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THE PITTSBURG REDUCTION CO., says an Ogdensburg item, is to erect five large factories for the manufacture of aluminum at Massena, N. Y. The company has secured 100 acres of land and will employ about 500 men, the cost of the plant involving an expenditure of about $1,000,000. Water was turned into the fore-bay of the St. Lawrence Power Co.'s power house, at this point, on May 15; and the company is now ready to commence the generation of the 35,000 E. HP. for which the turbines are in place.

THE SOUTH WALES ELECTRICAL POWER CO., says the "Iron and Coal Trades Review," of London, has been organized to create and distribute electric power over an area of about 1,634 sq. miles. This area includes the whole county of Glamorgan and part of Monmouth, South Wales; supports a population of over one million and contains upward of 2,400 collieries and factories. The first generating station will be at Pontypridd, with 15,000 HP. in engines, dynamos and boilers provided, but having a completed capacity of 75,000 HP. The mains for conveying the power generated will be in cable form, laid in earthenware troughs, 2 ft. under ground; the troughs will be filled in with molten bitumen, after the cables are in place, and the tile covering is also set in bitumen. These first cables, extending to the Rhondda Valley, are to carry energy at a pressure of 12,000 volts.

200,000-LB. CAPACITY STEEL CARS to the number of 100 are said to have been ordered from the Pressed Steel Car Co. by Jones & Laughlin, of Pittsburg, according to a press dispatch.

COMPRESSED AIR FOR PUMPING OIL WELLS is to be tried in connection with some of the Beaumont wells that have lately ceased to "spout." The Spindle Top Power Co. is reported as having commenced the erection of an enormous compressed air plant, and it proposes to sell the product to those needing it. Compressed air has already been successfully tried on a small scale as a substitute for gas pressure.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on May 17 on the Chicago, Burlington & Quincy R. R., near Hyannis, Neb. An eastbound fast passenger train collided with a westbound extra stock train. Four persons were killed and several others injured.

AN APPALLING MINE DISASTER happened on May 19, at the Fraterville coal mine, near Coal Creek, Tenn. The men had just entered the mine to begin their day's work, when a terrific explosion was heard which sent bursts of flame from shafts and air-openings. Rescuers at once entered the mine, and after many hours' labor finally succeeded in reaching the distant workings where the miners had been employed. Not a single one was found alive. There were probably considerably over 100 men in the mine at the time of the explosion, and the only one known to be left alive is a man who had been near the mouth of the mine at the time, and who was blown out of the shaft badly injured. Seventy dead have already been taken out.

A STORM IN THE MISSISSIPPI VALLEY on May 18 and 19 wrought havoc at many points, from the Gulf coast of Texas north to Wisconsin, and caused a great loss of life. Winds of hurricane intensity accompanied by much rain are reported from nearly all points in Texas, from Missouri, Iowa, Dakota and Wisconsin. A number of washouts on railways, extensive interruption of wire communication, damage to crops, and some fatalities, resulted from the storm over this area. By far the worst of the destruction, however, occurred in Goliad, a town of about 1,500 inhabitants, in southeastern Texas. Here the storm was cyclonic in its nature; it blazed a path for itself through the town, leveling everything in a strip several hundred yards wide and a mile and a half long. The cyclone, which was preceded by a heavy downpour of hail, lasted only a few minutes. When it was over it was found that nearly 100 persons had been killed outright, and as many others injured.

AN AIRSHIP ACCIDENT caused the death of two aeronauts in Paris, France, on May 12. A Brazilian, M. Augusto Severo, who had been experimenting with dirigible balloons for some years, recently designed and had built for him an unusually large airship of this class, and was to make his first flight with it on the fatal morning. The accident occurred very shortly after the beginning of this flight, while the balloon was apparently over a thousand feet above the ground. In some unknown manner the balloon exploded, and fell to the ground, killing both its occupants, one of whom was M. Severo himself.

A DRAWBRIDGE ACCIDENT was narrowly averted at Chicago, May 15, when an eastbound electric train on the Metropolitan Elevated Ry. started to run on the Chicago River bascule bridge just as it was being opened to let a steamer pass. The signals appear to have been at danger, and the motorman failed to see or obey them in time and could not stop his train until the first car had run partly upon the rising leaf of the bridge. The car was derailed, and its rear truck jammed in the opening at the heel of the bridge, but nobody was injured. The bridge consists of two double-track bridges normally operated as one four-track bridge, but the two parts were uncoupled and the south side lowered to carry the traffic on the two unobstructed tracks. This railway uses at some of its junctions the Rowell-Potter automatic stop for applying the brakes to a train overrunning the "stop" signal, but this appliance is not used at the bridge signals.

THE WEST INDIAN VOLCANIC DISTURBANCES are much more extensive than was to be inferred from the first news after the catastrophe of May 8. At Martinique the disturbance was rather localized, since it appears that little damage was done outside of a circle five miles from Mont Pelée. This volcano is, however, still active, and minor eruptions occur at frequent intervals. An enormous amount of "ashes" or "volcanic dust" has been ejected from the crater (or craters, as there is reason for thinking that a number of new vent-openings have been formed), and this matter is carried even to Fort de France, over ten miles from the volcano. Bits of news that are just coming in go to show that most extraordinary and alarming phenomena were observed in St. Pierre for almost a week preceding the great eruption: large amounts of hot gases were poured over the town from the volcano, earth tremblings occurred, lava flowed down the mountain side, and a continuous rain of "ashes" fell over the town. Similar conditions still prevail, but it is impossible to approach within a few miles of Mont Pelée, so that only distance observations can be made. The St. Vincent catastrophe is far more serious and more extensive than was thought at first. About 2,000 were killed, and in this respect the Martinique horror is much the greater; but the property damage and general devastation at St. Vincent is the more complete and extensive, and probably the more important as concerns the nature of the disturbance. The whole northern half of the island is covered with "ashes" and lava, and large amounts of the "ashes" are carried far around and deposited over the neighboring islands. The region immediately surrounding the volcano of La Soufrière has become itself volcanic; the topography of the region is greatly changed, parts of the land have sunk and become inlets of the sea, and fissures in the earth all around the mountain act as small craters themselves. The reports indicate that the greater part of the island of St. Vincent has been rendered uninhabitable. It may be noted that seismic disturbances have been observed during the past week in Portugal and in Guatemala, and that the activity of the Guatemalan volcanoes has been slightly greater.

AN ELECTRIC POWDER-THAWER has been made under the direction of Mr. E. F. Stuart, Chief Engineer of the Trade Dollar Con. Mining Co., at Silver City, Idaho. As described and illustrated in the "Mining and Scientific Press," of San Francisco, this device consists of a magazine 5 ft. long, 4½ ft. high and 2 ft. deep, set up 22 ins. above the floor and lined throughout with galvanized iron. The eight galvanized iron trays hold about three boxes of powder, and a ventilator in top regulates the temperature, which is kept at 70° to 75° F. The galvanized iron heater is 20 ins. diameter and contains 30 coils of No. 22 twined steel wire zig-zagged between the top and bottom of the "stove." The bottom of this stove is open, but a 3-in. pipe connects the closed top with the magazine; this pipe contains a regulator, and all connections with the magazine and ground are thoroughly insulated. The electric current used throughout the mine is of 400 volts, and this is the voltage employed at the heater. One wire of a 116-volt 16-c. p. lamp, used to light the magazine, is attached to the main 400-volt line, while the other wire is carried through a switchboard to one of the resistance coils—a sufficient number of coils being cut in to equalize the high voltage of the first wire. From 2 to 3 hours are required to thaw the powder, which is then taken off the trays and repacked in the boxes for use. While close watch is maintained to keep the temperature about 70°, it has been demonstrated that the maximum heat is 80°—with damper closed and heater at full capacity. In all four of these thawers are now in use at the mines in that vicinity.

A FAST RAILWAY RUN was made on May 9 on the Wabash R. R. between Decatur and Granite, Ill. The total distance between these two points is 105 miles, and it was covered in 95 minutes, of which 5 minutes should be deducted for stops. The average speed over the whole distance, including stops, was therefore 66 miles per hour, or, excluding stops, 70 miles per hour. The fastest measured speed made on any portion of the trip was between Boody and Blue Mound, Ill., a distance of 6 miles, covered in 4 minutes, or at a speed of 90 miles per hour. The train, which was one of the regular limited trains running between Chicago and St. Louis, consisted of an engine and four cars. The engine was of the Atlantic type, with cylinders 19 × 26 ins. and 79-in. drivers.

AN OIL-BURNING STEAMSHIP was launched from the yards of the New York Ship Building Co., at Camden, N. J., May 19. The ship was the "Nebraskan," built for the American-Hawaiian steamship line. The boiler furnaces are fitted to burn either oil fuel or coal.

STATE REGULATION OF ENGINEERING PRACTICE is proposed in Louisiana. The Louisiana Engineering Society has drafted a bill to be introduced in the state legislature, prohibiting the practice of engineering or surveying by incompetent persons, and providing for a state board of engineering examiners. A similar bill was introduced at the last session of the legislature, but failed to pass.

THE LAKE ERIE-PITTSBURG SHIP CANAL is again before Congress in the form of a bill to incorporate the Lake Erie & Ohio River Ship Canal Co., presented by Congressman Dalzell. The bill would provide for a canal at least 15 ft. deep, with a standard cross section of not less than 2,000 sq. ft.; locks to be not less than 340 ft. long between quoins and 45 ft. wide between walls. The total lockage between the Ohio River and Lake Erie is not to exceed 690 ft.; and the capital stock is not to exceed $300,000 per mile of canal constructed. The bill is backed by commercial statistics proposing to show that the construction of the canal would save much money in transportation. The length of the main canal would be about 122 miles, with 34 locks.

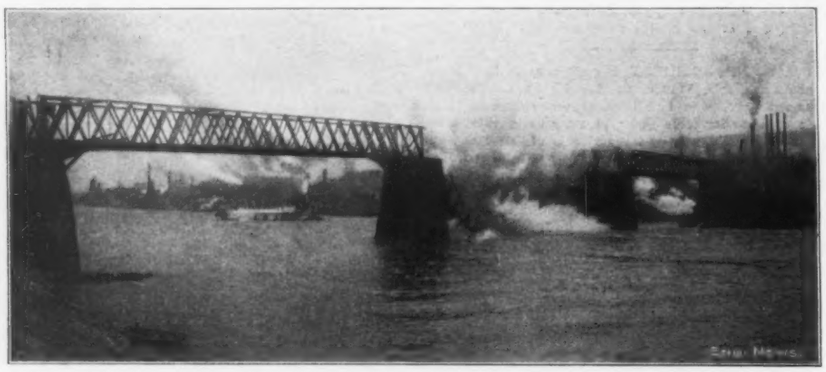
FOR THE CONSTRUCTION OF RAILWAYS in South Africa, Lord Milner has asked an appropriation of $15,000,000, and an instalment of $4,175,000 has already been granted. Of the total sum $5,000,000 is to be expended for engines and rolling stock. Sir Percy Girouard, the present Director of Military Railways, will be the General Manager of the combined lines of the Transvaal and Orange River Colonies, says the "British and South African Export Gazette." The same journal says that the authorities of Cape Town are raising a loan of $2,500,000, to be expended in building a 30,000,000-gallon reservoir, buying up the Cape Town Districts Water-Works Co., Ltd., and the introduction of a complete drainage system. The town of Port Elizabeth has succeeded in having a bill passed permitting it to expend about $5,000,000 in supplementing the water supply, and building a telegraph and telephone line.

THE INDUSTRIAL AND ART EXPOSITION of Düsseldorf, Germany, was opened on May 1 by the German Crown Prince, the patron of the enterprise. The exposition is devoted to the manufactures and industries of the Rhenish and Westphalian provinces, and is joined with a national German art exhibition. The grounds occupy a former island on the right bank of the Rhine, which was reclaimed and filled in the year 1898 as part of a system of regulation of the Rhine carried out by the city of Düsseldorf. A number of German technical and industrial societies will hold their conventions in the exposition city during the summer.

REMOVING AN OLD BRIDGE BY DYNAMITE.

The city authorities of Pittsburg recently decided to replace with a more modern structure the wooden Howe truss bridge crossing the Monongahela River at 10th St., Pittsburg, Pa. The contractor for this work decided to blow up each span separately with dynamite, as being the quickest and most convenient method of getting rid of the old structure.

For this purpose dynamite cartridges were inserted in the lower chord of the bridge trusses at such points as were deemed most effective, and these points were connected and the charges exploded by an electric battery. The illustration shows the result of the first explosion. The entire superstructure was torn from the piers and fell into the water. The masonry of the piers was protected as much as possible for future use. No accident of any kind occurred, and the operation was successful throughout.



REMOVING WITH DYNAMITE THE OLD SPANS OF THE MONONGAHELA RIVER BRIDGE, AT PITTSBURG, PA.

SEPARATION OF OIL FROM CONDENSED STEAM.*

By J. R. Bibbins,† B. S.

The object of the experimental work detailed in the following pages was to evolve some method of freeing engine condensation of entrained oil occurring either in free form or entirely in the form of emulsion. The objective point of application of this prospective method of oil separation was the condensing plant of Station "C" of the Detroit Edison Company, which is at present operated in connection with two 400-HP. McIntosh & Seymour tandem compound engines during periods of alternate heavy and light load. The relative positions of engines, condensers and exhaust piping are shown in Fig. 1. The condenser is a 1,600-sq. ft. Worthington surface condenser, and discharges its condensation in either or both of two ways, namely: First, by means of a small automatically controlled pump into a coke filter constructed especially for the purpose of removing the oil, and thence directly into the boiler feed. The filter is shown in vertical section in Fig. 2. Second, by means of a siphon leg overflow directly into the sewer. The outlet from the filter shown in Fig. 2 taps into a 4-in. feed pipe leading from the discharge of the condenser circulating pump, from which the boiler feed is drawn at 150° F. average. The plant does not use city water directly for circulation and consequently for cooling purposes, but employs a cooling tower which receives and cools the hot discharge from the circulating pump. The before-mentioned tap from pump discharge is then a tap from the hot circulation water entering the tower to be cooled; this water then being more suitable for boiler feed than cold water from city mains.

OCCURRENCE OF OIL.—No trouble was experienced in the operation of the plant as long as the condensation was allowed to overflow into the sewer and the boiler feed was taken directly from the hot pump discharge from the condenser. After the instalment of the special coke filter the condensation was then pumped through the filter and thence into the boiler, thus completing the water cycle (boiler-engine-condenser-filter-boiler) without serious waste. This operation continued for some months, during which time the coke was renewed at intervals of three or four weeks until it was found that considerable oil had collected in the boilers, presumably due to the faulty action of the filter. The filter is constructed as shown in Fig. 2, consisting of a 10-ft. length of 15-in. wrought iron pipe with flanged ends. A settling chamber is provided at the top and bottom and the coke is closely packed in the intervening space between these chambers, strainers being provided to allow free movement of water from chamber to chamber, but confining the coke to the central portion of the filter. A hand hole at the bottom, and the removable top, furnish means for cleaning and refilling with fresh coke. The oily condensation enters at the top and when purified finds exit at the bottom. The blow-off taps into the upper chamber for the purpose of moving surplus free oil which collects there. This blow-off is usually operated at intervals of two hours. The filter is operated under pressure due to the column of tower water, 30 ft. high, or about 15 lbs. pressure. The size of coke used is average pea, varying from ½ to 1-in. outside dimension. The discharge from the blow-off consists of considerable quantities of heavy black oil and much oil in the shape of emulsion, but not so easily detected on account of its light color and extreme dilution by pure condensed steam. An examination of the filter at the time of renewal of coke reveals the entire interior heavily lined with black oil, while the coke itself, especially at the top, is also entirely coated with the black oil. A shorter run would doubtless leave the lower layers of coke somewhat freer of the oily coating than the top layers, as the zone of greatest activity gradually descends from top to bottom. It is apparent that the presence of part of the oil which found its way into the boilers was due to overworking the filter, but subsequent experiments prove the filter to be entirely incapable of freeing the condensation of oil in the form of emulsion.* The oil used in the engine cylinders is a special brand manufactured by Wilson, Clark & Co., Cleveland.

*The emulsion above mentioned is a mechanical mixture of the most intimate nature of oil and condensed steam. When uncontaminated by black or free oil, the emulsion presents the appearance of a milky, opalescent liquid with a slight greenish-yellow tinge.

Samples drawn from engine reheater traps on the exhaust system are extremely dense and of more pronounced color than samples from the condensation, which contain such a large percentage of pure condensed steam that no color is apparent, though the liquid still retains its milky or opalescent appearance.

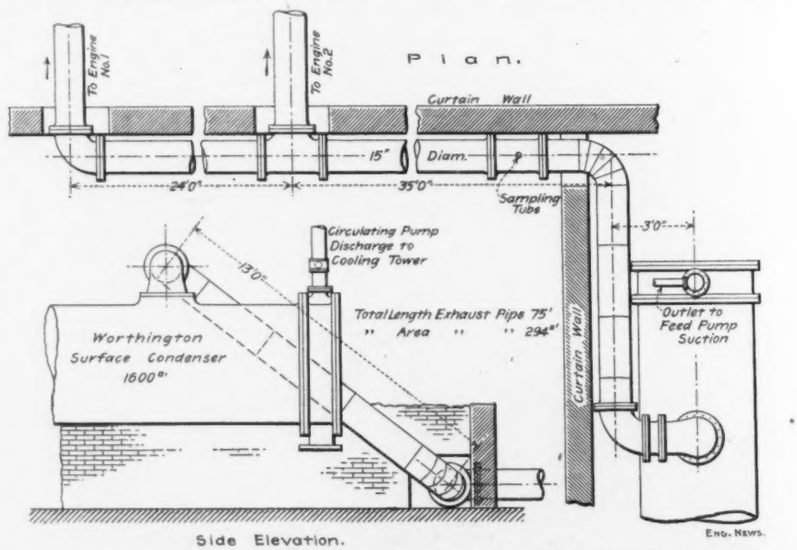


FIG. 1. PLAN OF EXHAUST PIPING AND CONNECTIONS IN STATION "C" OF EDISON CO., DETROIT, MICH.

EXPERIMENTAL WORK.

In searching for results of previous work [illegible] this line it became evident that the actual [illegible] aration of entrained oil had never been [illegible] on a large scale either by mechanical [illegible] or by chemical means. Several forms of water-[illegible] apparatus, however, separate oil in small [illegible] together with other chemical impurities, but they [illegible] attempt to purify condensation or dirty drips from [illegible] engine. It was then apparent that experimenal [illegible] necessary to determine the nature of the mixture, [illegible] mechanical or chemical. The apparatus shown in [illegible] was then constructed with a view to furnishing [illegible] greatest latitude possible in experimental work. Two [illegible] servation cylinders of heavy white glass, fitted with [illegible] heads and rubber gaskets, furnished means of observing [illegible] whatever changes and reactions took place from time to [illegible] time. Each head was tapped with a 1¼-in. nipple [illegible] furnished with air-tight gage cocks, the cylinders being [illegible] interconnected, as shown, with an opening for pressure [illegible] or vacuum gage. In one of the cylinders was inserted a [illegible] steam coil of brass tubing and a thermometer cup. The [illegible] whole was clamped together by two white oak heads and [illegible] five 1-in. bolts, the upper and thinner head being reinforced by 1¼-in. angle iron. This was necessary because [illegible] the slightest irregularity in calibrated distance from head [illegible] to head resulted in the opening up of one gasket or both [illegible] under pressure. This apparatus proved capable of withstanding 90 lbs. steam pressure, and would carry 65 lbs. air pressure for 40 hrs. with a drop of 10 to 15 lbs.

MECHANICAL TREATMENT.—With this apparatus the following experiments were performed to determine the effect upon clear emulsion of: (a) pressure; (b) temperature; (c) vacuum; (d) aeration; (e) chemicals; (f) time element. The emulsion was admitted by a funnel upon the cylinder was about half full, the pressure being controlled by valves and distributed as desired between the cylinders as indicated by the gage on the header.

These experiments and their results may be summarized as follows:

(a) Cylinder No. 1 half filled with stock emulsion obtained from trap on high pressure exhaust, temperature 210° F. at start. Air pressure gradually applied from 0 to 65 lbs. No disintegration at the end of 3 hrs. Left same at 50 lbs. for 16 hrs. Slight deposit of oil on side of cylinders.

(b) 1. Hot sample emulsion at 0 pressure. Admitted live steam at bottom cock for ½ hr. Temperature 212° to 215°, according to velocity of entrance. No perceptible change in conditions—same after 12 hrs. standing.

(b) 2. Hot emulsion subjected to 50 lbs. initial air pressure. Also ran steam through coil for 1½ hrs. Pressure, 65 lbs. Temperature 265° F. at end of test. Decided deposit of heavy black oil on glass walls. Solution greatly clarified, though still somewhat milky and discolored from metal pipe. Allowed to stand, and filtered. Filtrate perfectly clear and free from oil.

(b) 3. Sample emulsion hot from engine. Subjected to 50 lbs. initial air pressure. Admitted live steam at the bottom cock, raising pressure to 80 lbs. and temperature to 280° F., beyond which ebullition became too violent. At the end of experiment there was a heavy deposit of black mineral oil on glass walls. Solution quite clear. Filtered, filtrate clear as crystal. Stood two days; slight deposit of iron oxide in the form of yellow precipitate; no traces of oil.

*A paper read before the Detroit Engineering Society Jan. 24, 1902. Reprinted from the "Journal of the Association of Engineering Societies," March, 1902.

†56 Hastings St., Detroit, Mich.

(c) Subjected hot and cold emulsion to 25-in. vacuum for 1½ hrs. No change.

(d) 1. Aerated hot emulsion until cold at 50 lbs. pressure. No results.

(d) 2. Aerated cold emulsion at 50 lbs. pressure and at atmosphere by forcing air into the bottom. Very slight deposit.

(d) 3. Aerated hot sample at 24-in. vacuum for 1 hr. Very slight deposit.

(e) Cold sample at 0 pressure. Injected strong solution of tri-sodium phosphate. Aerated slowly for ½ hr. No deposit.

(f) Sample drip from exhaust head of engines running non-condensing. Stood 30 days. Oil coagulated perceptibly in form of a creamy curd of slightly less specific gravity than water. No perceptible change in the body of liquid.

The inference to be drawn from these experiments is that, of all means thus far available, the application of higher temperature is the only mechanical means of coagulating and separating entrained oil in the form of emulsion. This method, however, is the most inconvenient of all the mechanical methods, as it involves a live steam feed water purifier and oil filters combined, of sufficient capacity to handle the total condensation plus losses. It will also be at once recognized as the operation which takes place in the interior of the boiler, when under pressure, the oil being forced out of its entrained condition by high temperatures and deposited on the heating surfaces of the boiler, thereby seriously reducing its operative efficiency.

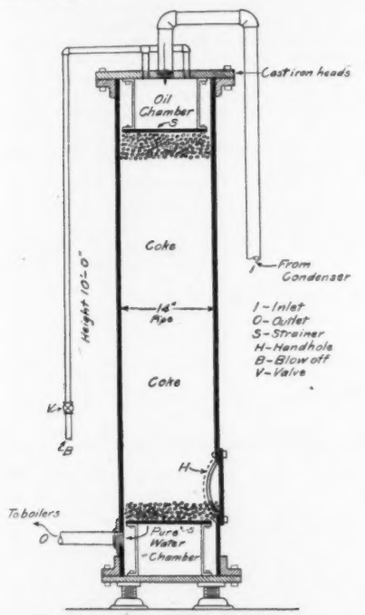


Fig. 2. Experimental Coke Filter for Removing Oil from Condensation Water.

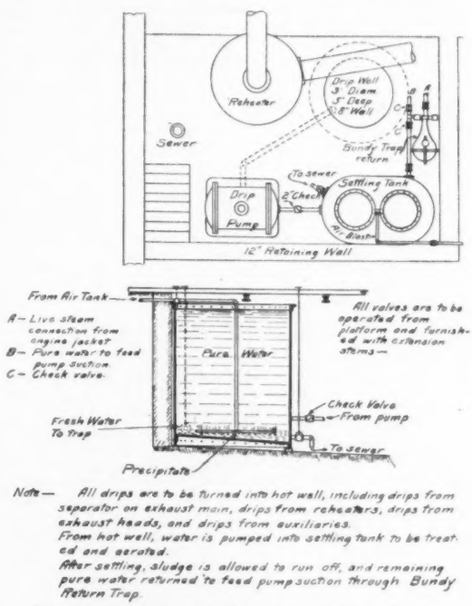

Reheater
Drip Well 3' Diam. 5' Deep 8" Wall
Sewer
Bundy Trap return
To sewer
Settling Tank
Drip
Check
Pump
Blow off
12" Retaining Wall
From Air Tank
A—Live steam connection from engine jacket
B—Pure water to feed pump suction
C—Check valve
All valves are to be operated from platform and furnished with extension stems—
Pure Water
Check Valve From pump
Fresh Water To Trap
To Sewer
Precipitate
Note— All drips are to be turned into hot well, including drips from separator on exhaust main, drips from reheaters, drips from exhaust heads, and drips from auxiliaries.
From hot well, water is pumped into settling tank to be treated and aerated.
After settling, sludge is allowed to run off, and remaining pure water returned to feed pump suction through Bundy Return Trap.

Fig. 5. Design for Oil Separating System for Station "C," Edison Illuminating Co., Detroit, Mich.

An investigation into the chemical means of purification became at this point advisable. Before taking up this work, the sampling apparatus was constructed, as shown in Fig. 4, for the purpose of drawing out samples of liquid or steam as they occur under normal working conditions in the exhaust main of the plant. The pipe section represents the 15-in. exhaust main conveying exhaust steam from two 400-HP. engines to the condenser. Fig. 1 shows the point of application of the sampling pipe to the exhaust main. A 2-in. hole was tapped in the top of the pipe at a point about 15 ft. from the condenser intake and a special packing box inserted as a plug. Through this box a ⅜-in. brass sample pipe could be moved up and down at will, thus allowing the removal of samples of exhaust at different levels in the main. A specially constructed hand pump, capable of producing a 25-in. vacuum, was used to work against the running vacuum, which usually was required to be lowered to 20 ins., in order to give sufficient difference in pressure to obtain samples of any volume.

The glass observation flask E was used to catch all the liquids, while the steam was condensed in the cooling coil G, and caught in flask F. When the apparatus was not in use, a ¼-in. pipe plug was inserted in place of the sample pipe, thus preventing any leak and the necessity of removing the larger plug during operation. The sample pipe being graduated in inches enabled observations to be made at different elevations in the interior of the pipe. In exploring the interior during operation three facts became at once apparent:

(1) No oil occurred in the free or normal state as it was injected into the cylinder of the engine. (2) The exhaust steam from the top of the pipe to within a variable distance from the bottom (0 to 4 ins.) was pure steam, uncontaminated by emulsion, in a vaporous state. (3) Samples of liquid lying or moving along the bottom of the pipe were, without exception, emulsion of a light greenish-yellow tint, uncontaminated by black oil. They apparently were the same mixture that was obtained from the high-pressure exhaust of the engine, minus a small amount of black oil, which is removed from the condensing system by a steam trap located at the lower end of the receiver chamber of the engine reheater. A question here arises relative to the appearance of the black oil in the filter shown in Fig. 2. This oil did not appear in this form in the exhaust main, nor did it appear in experiments c and d, vacuum and aeration, previously described, where conditions of temperature and pressure were reproduced from those which obtained in the condenser proper.

Two explanations are apparent: (1) The uncombined oil which does not show in the sampling apparatus is confined entirely to the dry sides of the pipe, where it is forced along by superficial friction, due to the enormous velocity of the passing steam. (2) The separation in the condenser may take place under different conditions than those reproduced, the sudden condensing of the steam having possibly some effect at present unknown. The first supposition is somewhat invalidated by the fact that if free oil existed on the sides of the pipe, it would certainly tend to gravitate to the lower surfaces, if not to the basin, of the pipe, and there come within range of the sampling pipe. The second supposition seems the more probable, but this point can be better elucidated by further experiment. Concerning the presence of emulsion, experiment b, temperature, proved that the mineral oil was transformed from the emulsion to the free state only by high temperatures and high pressures, the latter being a seemingly unimportant factor in the process. These conditions correspond to the conditions obtaining in the high-pressure cylinders, but not in the low-pressure cylinder. Under the supposition that emulsion is formed in the low-pressure cylinder, the non-appearance of free oil in the exhaust main seems to indicate that the limiting temperature of separation is never reached, and, consequently, that the trap on the reheater should remove all free oil escaping from the high-pressure cylinder, and thus free the system of this objectionable feature. The uncertainty of performance in the condenser, however, necessarily derives this supposition of its main value. A further point not yet mentioned concerns the effect of pockets in the exhaust system. The first experiments with the sampling apparatus in the location shown in Fig. 1, revealed a depth of 3 to 3½ ins. solid emulsion in the basin of the exhaust main. Subsequently the condensing system was shut off, and shortly thereafter the contents of the exhaust pipe sampled. It was found to contain pure vapor to within 5 ins., of the bottom of the basin, and solid emulsion thereafter. This was due to the presence of a pocket in that part of the pipe, in which had accumulated 5 ins. of liquid, thus reducing the effective area of the exhaust main 38%. During operation the upper surface of this body of liquid would probably assume a concave form, thus accounting for the lesser depth noted at this time. As the exhaust pipe had been in constant use for nearly a year, it is probable that any additional body of liquid from the engine would be swept through to the condenser, as the depth of 3½ ins. could easily have collected in a few hours. This, then, being the limiting depth, an increase of which would be prevented by the increase in velocity of the passing steam. The foregoing observations seem to point to the necessity of an efficient separator, located at the lowest point in the main exhaust line. This question will be taken up later.

CHEMICAL TREATMENT.—In preparation for experiments on chemical purification of the emulsion a consultation of the various authorities upon practical chemistry indicated in a general way the method of chemical treatment for purifying liquids contaminated by oleaginous matter.

All oils ordinarily used for lubricating purposes are composed of animal, vegetable or mineral oils, either in the pure state or in the form of a mixture of various percentages of each separate constituent. The oils most commonly used for this purpose are: First, mineral—heavy, medium, light or paraffin (petroleum distillates); second, vegetable—olive, rape and castor; third, animal—lard, neat's foot and sperm; fourth, resin oils sometimes used as adulterants, but are very gummy in their nature.

The proportions of each constituent in compounded oils vary entirely with the work for which the lubricant is intended, the heavy oils being used where great pressure or high temperatures obtain, and the lighter oils for light-running machinery. Valve, engine and dynamo oils are usually compounded principally of mineral oils and varying amounts of lard, tallow and rape oil, or even solid tallow. All fixed or fatty oils may easily be recognized and distinguished from mineral oils by their inclination to saponify in the presence of a base, while the mineral constituents remain absolutely inert in the presence of either acid or alkali, and exhibit no tendency to oxidize, as do fixed oils. Fixed or fatty oils are composed of fatty ethers or esters, formed by the union of an alcohol with a fatty acid radical; thus glyceryl $C_3 H_5$, which is the radical of glycerol or glycerin $C_3 H_5 (O H)_3$ combines with an acid radical R to form the resultant oil $C_3 H_5 R_3$ (olein, stearin, palmitin).

$$C_3H_5 (OH)_3 + 3 (R) = C_3H_5 (R)_3 + H_3 O$$

Inorganic analogue $2 KOH + H_2 (SO_4) = K_2 (SO_4) + 2 H_2O$.

Saponification is the reverse of this reaction, viz., the splitting up of an ester or ether into an alcohol and a fatty acid, and may be brought about either by hydrolysis (heating with steam under pressure) or by the presence of a strong base. As an example of this disintegration:

(a) Olein + water (steam) = glycerol + oleic acid.
$C_3H_5 (C_{18}H_{34}O_2)_3 + 3 H_2O = C_3H_5(OH)_3 + 3 C_{18}H_{34}O_2$.

This reaction takes place in steam cylinders, forming metallic soaps and salts at the expense of cylinder walls, stuffing boxes, etc.

(b) Olein + 3 KOH = glycerol + 3(potass. oleate)
$C_3H_5(C_{18}H_{34}O_2)_3 + 3 KOH = C_3H_5(OH)_3 + 3 K(C_{18}H_{34}O_2)$.

Here the alcohol is liberated (as also by hydrolysis), while the acid combines with the strong base to form soap. These soaps are easily decomposed by mineral acids, thus:

Potass. oleate + H Cl = K Cl + oleic acid.
$K(C_{18}H_{34}O_2) + H Cl = K Cl + C_{18}H_{34}O_2$,

the salt going into solution, while the fatty acid is set free. Mineral oils, if boiled with K O H, suffer no change, while fixed oils or esters saponify, forming soaps and glycerol, which may be readily washed away. These reactions furnish simple and accurate means of analyzing quantitatively the various brands of engine and dynamo oils in use. The result of using oils containing esters of fatty acids is shown in the following analysis of cylinder deposits from a large compound engine cylinder (high pressure)*:

	Pr. ct.
Moisture	13.10
Oils sol. in ether, animal	8.15
Oils sol. in ether, mineral	7.86
Hydrocarbons insol. in ether	1.67
Soap	2.10
Oxide iron and aluminum	6.81
Fixed carbon	2.71
Si O_2	3.65
Ca CO_3	43.22
Mg CO_3	10.17
Undetermined	0.44
	100.00

In casting about for chemical means of separating oil in the condensing plant previously described the idea of saponification naturally suggested itself, in the hope that an insoluble soap might be found which would at once give the desired reaction. Of these the calcium, aluminum and magnesium soaps seemed the more promising, and would indeed have proved successful if pure fixed oils had been used. As no saponification could be detected, the oil itself was examined by the method indicated above, and found to be pure mineral oil, consequently unaffected by acids and bases alike. Samples of the emulsion subjected to the most sensitive test proved entirely inert, and showed conclusively that the oily mixture obtained from the engine drips and exhaust main is a mechanical mixture of water and mineral oil, but, withal, so complete a

*Stillman, "Engineering Chemistry."

mixture as to appear like a chemical one, showing no evidence of oily or other foreign matter in mechanical suspension.

The emulsion having thus far resisted all attempts at chemical disintegration, a series of coagulative tests was made,* employing successively fuller's earth, powdered marl ($Ca\ Co_3$), slaked lime and a double treatment of alum and $Na_2\ C\ O_3$.

The fuller's earth and calcium compounds produce the most gratifying results. In each case the chemicals were mixed with water to the consistency of thin paint, and, in this state, added to the sample of emulsion, the whole being then agitated for a short period and allowed to settle. With the calcium compounds coagulation occurred almost instantly, and a milky-white curd of considerable volume and weight settled slowly to the bottom, leaving the liquid quite clear, although slightly alkaline. Fuller's earth produced the same results after a longer period of agitation and settling, with the exception that after the coagulated oil had settled to the bottom in the form of a grayish-brown sludge, a fine, cloudy precipitate still hung

Fig. 3. Apparatus Used in Experiments on Oil Separation.

in suspension for some time, which finally settled also, leaving the solution clear and without acid or basic reactions.

It was found that freshly prepared milk of lime used as a coagulator, imparted to the filtrate or clear liquid a much stronger basic reaction than powdered chalk or marl. It was also found that the solid constituents of the lime mixture were alone responsible for the coagulation, which was proved by treating emulsion with pure lime water decanted from a quantity of milk of lime, in which this solid matter had been allowed to settle. No coagulation was observed.

FEED-WATER PURIFICATION.—In order to definitely ascertain which of these reagents may be most successfully applied to any particular case of power station operation, the constituency of the feed water in its natural state should be considered. A chemical analysis of the water of the Detroit River by the Detroit Water Board reveals various impurities, as indicated in the table below. These analyses are not recent, but show a fairly uniform constituency.

Ingredients.		Date of observation—1861.	1872.	1879.	1879.
		Grains per U. S. Gall.			Pts. per million.
Calcium sulphate....	$Ca\ SO_4$	2.53	0.70	1.043	17.89
Calcium bicarbonate.	$Ca\ H_2\ (CO_3)_2$	1.652	4.11	3.353	67.49
Magnes'm bicarb'n'e.	$Mg\ H_2\ (CO_3)_2$	....	0.66	1.209	20.73
Potassium chloride..	$K\ Cl$	0.145	...	....	....
Sodium chloride.....	$Na\ Cl$	0.361	0.24	0.229	3.93
Sodium carbonate...	$Na_2\ Co_3$	....	0.32	0.394	5.75
Magnesium chloride..	$Mg\ Cl_2$	0.185	...	....	....
Aluminum phosphate.	$Al_2\ Po_4$	0.034	...	....	....
Iron carbonate	$Fe_2\ CO_3$	0.508	...	....	....
Potassium sulphate..	$K_2\ SO_4$	....	...	Trace	Trace
Alumina	.....	0.593	...	0.241	4.13
Silica	.....	0.263	0.28	0.306	5.24

The foregoing table shows the principal scale-forming ingredients of Detroit River water to be $Ca\ H_2\ (C\ O_3)_2$ 57.49 parts per million, $Ca\ So_4$ 17.89 parts per million, and $Mg\ H_2\ (CO_3)_2$ 20.73 parts per million. It is therefore necessary to adopt some means of relieving the boilers of this deposit. This may, of course, be accomplished by means of:

1. Live or exhaust steam purifiers, in which the water is heated by steam to a temperature at which the CO_2 dissolved in the river water is driven off, thus depriving the bicarbonates of their solubility and precipitating them in appropriate receivers. The extent of this reaction will depend upon the temperature of the steam, and, in order to effect the deposition of sulphates, the process must be supplemented by further treatment with soda ash or other compounds.

2. Porter-Clark process. This is entirely chemical and highly recommended by authorities on water purification, some advising single and others a double treatment, according to the constituency of the water and the conditions of treatment. In this process the bicarbonates are reduced to insoluble carbonates by a treatment of milk of lime, which is simply the liquid obtained by slaking freshly burned lime. The sulphates are treated with soda ash to form soluble $Na_2\ So_4$ which remains in solution, while the insoluble carbonates are thrown down. These reactions may, of course, take place inside the boiler, with a result that more frequent cleanings and blowings-off must be resorted to in order to prevent undue concentration and collection of the sludge. The extent of this concentration may be judged from the quantity of calcareous deposits in the cylinder noted in the above analysis, this having been carried over during priming of boiler. A proper system of treating would involve mixing and settling tanks of considerable size, as the reactions are necessarily slow, from one to two hours being required for their completion, unless an extra quantity of reagent be used to hasten them. In this case filters must be employed to remove the precipitates from suspension.

3. Other reagents and purifiers are, of course, employed, including caustic soda, trisodium phosphate, galvanic batteries and various brands of vegetable compounds (for the manager), but these are not essential to the subject in hand.

In view of the success of the lime treatment it is apparent that the same material may be advantageously used as an oil coagulator, the two systems being operated with a common reagent. Other reasons for the selection of lime are: (1) It acts much more powerfully and quickly in precipitating oily matter in suspension, thus shortening the time necessary to complete the reaction. (2) The hydroxide $Ca\ (O\ H)_2$, which invariably goes into solution with the water, is a highly desirable substance, and may be made a factor in the water-softening process above described. (3) The oil precipitate is much lighter and more mobile than that produced by the fuller's earth, and therefore easier to separate by filtration.

In a condensing plant where it is possible to make use of condensation for feed water, it is evident that the softening process may be largely dispensed with. Assuming the original contents of the boiler to be free from carbonate and sulphates, and condensation be entirely free from oily matter, either in the free or emulsion form, the small amount of fresh water necessary to add to the water cycle to supply leakage losses must of necessity be but a small proportion of the total volume of water in the boilers, and require little treatment. This fresh water supply would, of course, be greatly augmented if non-condensing auxiliaries were operated from the main battery of boilers, in which case the softening process would have to be applied to all fresh water entering the boilers. In the event of the main power system being operated independently of auxiliaries, the pure water cycle may be continued indefinitely by the addition of an amount of purified water sufficient to replace the above-mentioned leakage losses. This would, of course, require separate treatment of feed water for auxiliary boilers, which, however, would be necessary in any case, unless condensing auxiliaries were used.

DESIGN OF OIL-SEPARATING SYSTEM.

SEPARATORS.—A consideration of the results obtained with the apparatus shown in Fig. 4 makes it at once apparent that the chemical treatment of the entire condensation is unnecessary, for the reason that but a small proportion out of the total volume of condensation is oily emulsion, and this proportion, therefore, only requires treatment for entrained oil. If, then, an efficient separator be located in the exhaust main at a convenient spot, which will trap all emulsion and impurities, whatever then reachse the condenser should be pure steam, and after condensation may be pumped directly back to the boilers as pure feed. It is also apparent that a special [illegible] must be provided to remove entrained liquid from the [illegible] under working vacuum. Of the three separat[illegible] present market, Cochrane, Baum and Bundy, the [illegible] second seem to present the more desirable feat[illegible]

(a) Velocity of steam through passages is kept [illegible] value by the designers. This feature is, how[illegible] quired at the expense of floor space.

(b) An oil ring or annular pocket is provided, [illegible] entirely around the exhaust pipe entrance on th[illegible] side of the separator, for the purpose of arrest[illegible] ever heavy oil may creep along the walls of the [illegible]

(c) Extreme simplicity in absence of parts [illegible] become clogged by foreign matter (shreds of [illegible] etc.). In the case of the Bundy separator, in wh[illegible] trained liquid is arrested by a series system of rect[illegible] staggered grids, the net area or aggregate port [illegible] of each grid is approximately equal to the area [illegible] pipe, which would theoretically cause no change [illegible] locity of the steam. But the design and location [illegible] grids results in a large difference between act[illegible] effectual port opening, necessitating the introdu[illegible] other grids in the form of a series system to s[illegible] certainty of results. This multiplicity of baffles [illegible] direct line of steam current cannot but be opera[illegible] introducing a considerable resistance in order to d[illegible] the velocity of steam to a point where it will rele[illegible] trained oil, water, etc. The makers, however, claim that tests with a sensitive gage failed to reveal any appreciable drop in pressure over this grid work.

The velocity of the current of exhaust steam evidently has an important influence on the separating action; to determine the conditions in the present plant, three cases are calculated below, of which (a) and (c) are from actual operation:

(a) Corresponds to full-loaded engines, vacuum about 20 ins., 900 HP.

(b) Also at full load, provided 26-in. vacuum could be maintaned, 900 HP.

(c) Average morning load—full load on one engine, 400 HP.

The data involved are: Diameter exhaust main, 15 ins.; area, 1.23 sq. ft; average vacuum, 19.74 at 900 HP.; 20.85 at 400 HP.; steam consumption engine, 17.43 lbs.; full load (by test); volume, 1 cu. ft. steam, 72.50 at 20-in.; 173.23 at 26-in. vacuum. Then the respective velocities are:

$$(a)\quad \frac{900 \times 17.43 \times 72.50}{1.23 \times 60} = 15.400 \text{ ft. per min.}$$

$$(b)\quad 15{,}400 \times \frac{173.23}{72.50} = 36{,}800 \text{ ft. per min.}$$

$$(c)\quad \frac{400 \times 17.43 \times 173.23}{1.23 \times 60} = 16{,}400 \text{ ft. per min.}$$

The distinctive features of the three separators are:

Cochrane.—(1) An annular oil ring on the engine side, the surface of which is wetted by a small stream of water entering at the top of the annulus. (2) Sufficient sectional area for steam passages to reduce the velocity of steam to about 18,000 ft. per min., above which, it is claimed, oil will not be entirely released from the passing steam.

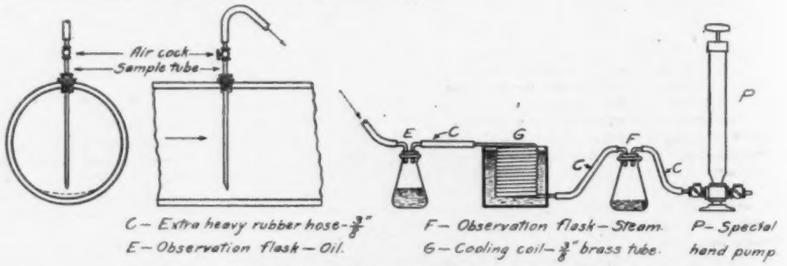


FIG. 4. APPARATUS FOR SAMPLING EXHAUST STEAM.

Baum.—(1) A hollow ribbed baffle, located in the middle of the steam space of the separator and kept at a low temperature by circulation of water in the interior, which causes the ribbed surface to be covered with a film of moisture, which, it is claimed, isolates oil from the impinging steam. (2) The steam current is allowed an easy turn around the baffle, and is not confronted by a flat or normal surface, from which the impinging liquid might rebound into the steam current.

Bundy.—A series system of removable grids, which may be inspected and cleaned from time to time, thus giving an indication of the conditions existing in the exhaust mains and preventing foreign matter (such as packing, fiber, etc.) from clogging up the condenser passages. As to the relative merits of these oil separators, there are, unfortunately, no exact data available. In a test of a steam separator* of the baffle plate design (such as the Austin), Mr. Charles H. Emory gives the following data.

*At the suggestion of Professor Campbell, of the University of Michigan.

*Trans. A. S. M. E., 1899. Specific gravity of oil injected into steam current, 0.830, at 60° Fahr.

termined from careful laboratory determination of oil-separating properties:

	Lbs. oil injected.	Lbs. mixture removed.	Sp. Gr. mixture.	Per cent. oil recovered.
tion.				
1.....	1.86	2.81	0.930	58.6
2.....	3.05	5.10	0.942	53.0
3.....	0.14	1.82	0.940	42.0
Average				51.2

It is evident that any design of separator which does not completely arrest entrained liquid will not operate satisfactorily under vacuum conditions noted above.

TRAPS.—The Bundy automatic trap, with steam-balanced overflow valve, seems to be the only apparatus on the present market capable of automatically removing entrained oil or water from vacuum systems, and is used in connection with both Bundy and Cochrane separators. It may be located in any convenient position where sufficient difference in level between separator and trap may be obtained to permit of the transfer of entrained liquid from the former to the latter by gravity.

A form of hand-controlled trap much in use consists of a closed receiver, fitted with an internal float, which operates a whistle or electric alarm in order to notify attendant of the proper time for discharging receiver. This is accomplished by a three-way valve, which, when reversed by hand, cuts off communication with vacuum system and admits live steam into the receiver, expelling the contents by pressure through a check valve at the bottom.

DRIP SYSTEM.—In applying this system of oil separation to a condensing plant, it will be necessary to convey all oily drips from engine, pump, reheater and separator traps to an appropriate drip well or tank installed in some central and convenient location (such as a reheater pit). This method of collecting drips is usually applied to pure steam drips only from steam mains, while the foul drips are turned into the sewer. This, of course, should be continued independently of the purification system, as it would be unprofitable to mix pure and oily drips and then treat the whole for oil.

In order to ascertain the total amount of oily liquid to be purified, engines and auxiliaries were run non-condensing on one exhaust head and the drip therefrom collected and weighed. During the succeeding day, at corresponding time and load, auxiliaries were run alone on this same exhaust head. Weighing drip as before, the net engine drip was obtained by subtraction.

Duration of test, 1 hour.

Net average load, kilowatts	191
Total drip (1 engine and auxiliary), lbs.	450
Total drip, auxiliary, lbs.	70
Net engine drip, lbs.	380
Estimated engine drip, at 600 K-W., lbs.	1,200
Estimated total drip, lbs.	1,420
Estimated reheater drip (2 engines), lbs.	450
Total, oily drip per hour, lbs.	2,870
Or, gallons	344
Jacket steam (2 engines), lbs.	833
Pure steam condensation, lbs.	639
Total, pure drip per hour, lbs.	1,472
Or, gallons	176
Total station, gallons	520

The pure drips were determined at a previous test of the entire plant, and are nearly constant.

DRIP PURIFYING SYSTEM.—The special apparatus required for treating oily water consists of a mixing tank, a small pump, return trap and filter of the type previously described. Fig. 5 shows the general construction of the tank, built of No. 10 sheet steel, with sloping or conical bottom, this being necessary for discharging the precipitate into the sewer. An agitator is provided for thoroughly mixing liquid and reagent before precipitation, and consists of a double pipe ring, with numerous holes drilled on the upper surface, and supported near the bottom of the tank in a horizontal position. It is to be supplied with compressed air, which is available in every up-to-date plant. A check valve is inserted between the tank and pump; also on each side of the return trap. The sludge outlet is controlled by gate valve, and the pure water outlet and aerator by globe valves.

The method of operation is as follows: (1) Tank is filled from well by small pump. (2) Coagulator added from platform above. (3) Air valve opened and aeration continued for a predetermined interval. (4) After precipitation the sludge valve is opened, and closed when pure water appears at the outlet. (5) Trap valve opened, allowing contents of tank to be forced through filter into the pump suction of boiler feed pumps.

The amount of time required for the complete operation can only be determined by trial in each particular case, and obviously depends entirely upon the amount of oily matter to be removed; this in turn determining the amount of coagulator to be added. The lime liquor is most easily prepared by slaking a large quantity of fresh lime in a wood or brick receptacle, from which measured quantities are withdrawn for each reaction, proper precaution being taken to insure uniform consistency.

Judging from the results of laboratory experiments, a period of aeration of 3 to 5 minutes should be ample for completing mixture, and 10 to 15 minutes for settling, although this time may be shortened, if necessary, as the filter will absorb the small amount of fine precipitate which is not thrown down with the first precipitation of sludge.

The feasibility of this system of purification is, of course, determined entirely by the cost of city water treated for scale-forming impurities, as compared to the cost of the process, including attendance and repairs.

In the event of pure water being employed for continuous operation, the methods of supplying same to system are: (1) Softening by chemical means a sufficient quantity of fresh river water. (2) Purifying the same amount of oily drip. The latter is obviously the better method, as it returns to the boilers pure water, while the former returns softened water containing $Na_2 So_4$ in solution.

With the low water rate of the city of Detroit, 2¼ cts. per thousand gallons, it is doubtful if the system would be a profitable investment, unless, as before mentioned, it is desired to operate on a pure water cycle entirely. The separator on exhaust mains should, however, be retained in any case, thereby enabling a large percentage of condensation to be saved, irrespective of the drips. With higher water rates for large condensing systems, where waste from drips would be considerable, it is probable that the system could be employed to great advantage, both from the standpoint of saving in water bills and boiler maintenance.

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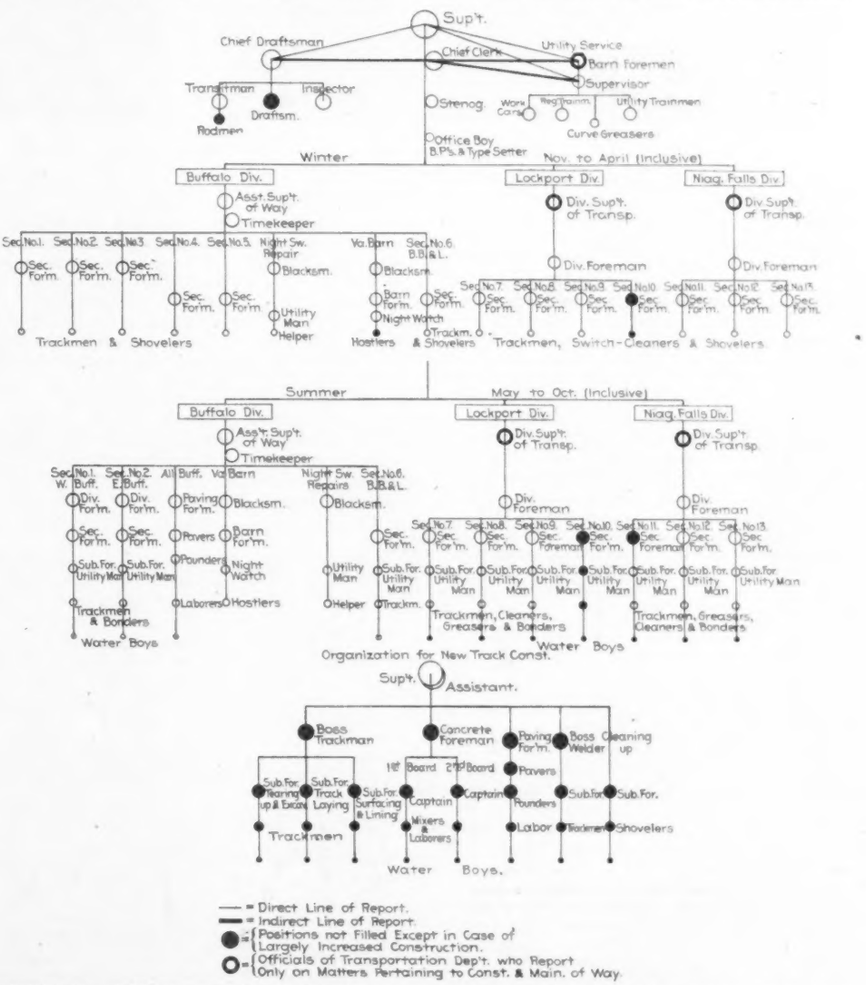
AN ADJUSTED BRAKE-PRESSURE DEVICE, which may be attached to any ordinary railway brake, is the invention of a Russian engineer, Mr. J. Georgoff, of St. Petersburg. The attachment comprises a small cut-off valve between the trple-valve and the brake cylinder, a small piston whose upper side is in communication with the brake cylinder, and a lever arrangement inserted between the car sill and spring and acting on the lower stem of the piston. The cut-off valve is pressed down against its seat by the air pressure from the triple-valve, aided by a small spiral spring. It is held open by the upper stem of the piston referred to, which piston, as was stated, is in its turn pressed upward by a force which is a definite fraction of the load on the wheels of the car. As soon, however, as the pressure in the brake cylinder rises sufficiently high, it forces this piston down against that upward pressure, and thus the cut-off valve is left free and at once closes. Conversely, when the brakes are released, the cut-off valve is opened (upward) by the pressure in the brake cylinder, and as soon as this pressure has dropped a little the piston again moves upward and its stem holds open the cut-off valve until the brakes are entirely released. The attachment is said to have been tested on the Russian railways and to have given excellent results. The device is described in some detail in the "Organ für die Fortschritte des Eisenbahnwesens" for April, 1902.



GRAPHICAL RECORD OF ORGANIZATION OF CONSTRUCTION AND MAINTENANCE OF WAY DEPARTMENT OF INTERNATIONAL RY. CO., BUFFALO, N. Y.

A GRAPHICAL RECORD OF ORGANIZATION.

The accompanying cut has been prepared from a blue-print furnished to us by Mr. T. W. Wilson, Assoc. M. Am. Soc. C. E., Superintendent of Construction and Maintenance of Way of the International Railway Co., Buffalo, N. Y.

As will be readily understood, the chart is a graphical record of the organization of the Department under Mr. Wilson's direction, and shows at a glance the responsibility borne by every man in the Department. The value of such a chart, both as a record and as a guide in studying contemplated changes in organization, must be evident to anyone.

ELECTRIC SEWAGE PUMPS, SEPTIC TANKS AND CONTACT BEDS AT FOND DU LAC, WIS.

By Geo. S. Pierson,* M. Am. Soc. C. E.

There was recently put in operation at Fond du Lac, Wis., a new system of sewage disposal, including an intercepting sewer, electric power pumping station, two septic tanks and four contact filter beds. The works were begun in 1901, with the writer as engineer, and although two of the contact beds were not completed the plant was put in operation on Feb. 11, 1902.

FIG. 1. GENERAL VIEW OF WORKS.

FIG. 2. NEARER VIEW OF PUMP HOUSE AND MAIN CARRIER.

VIEWS OF SEWAGE PUMPING STATION, SEPTIC TANKS AND CONTACT FILTER BEDS AT FOND DU LAC, WIS.
Geo. S. Pierson, M. Am. Soc. C. E., Engineer, Kalamazoo, Mich.

Figs. 1 and 2 are views, and Fig. 3 includes a plan and some sections of the disposal works. Before describing the plant in detail, some general information regarding the city and its sewerage system will be given.

Fond du Lac had a population of 12,024 in 1890, and 15,110 in 1900. A public water supply was introduced in 1885 by the Fond du Lac Water Co. The supply is pumped from artesian wells direct to the mains, but there is a small storage reservoir for fire protection. The beginning of a sewerage system, on the combined plan, was put in use in 1887. There were four miles of 10 to 30-in. vitrified sewers in use on Jan. 1, 1891, and in 1901 the mileage was about twelve. The area within the city limits is about 5½ sq. miles, nearly in the form of a square. As far back as 1891 there were nearly 100 miles of accepted streets, ten miles of which were paved or macadamized, and on May 1, 1902, there were 22½ miles of water mains and about 1,800 water taps or service connections.

The greater portion of the city lies upon ground which is but slightly elevated above the Fond du Lac River and above Lake Winnebago, into which the river discharges at the north city limits. The ground upon which most of the city is built is so nearly level that no adequate gradients could well be secured for sewers discharging into the river. This difficulty is further aggravated by the fact that at seasons of high water the water in the river rises from 5 to 7 ft. above lake level and backs up into the sewers for some distance, thus retarding their flow and causing sewage to escape into basements in some parts of the city. Notwithstanding these natural disadvantages, about twelve miles of sewers have been laid, discharging into the east branch of the Fond du Lac River.

During seasons of low water there is no current in the river except such as may be induced by the rising and falling of the water in Lake Winnebago, due to the variations of the wind. The current in the river during the dry season, therefore, alternates in direction and the discharge of sewage into the stream at such times has been very objectionable. It became evident to the city authorities that some radical change was desirable and necessary.† The work which is here described was carried out as a result of their investigations.

Upon an examination of the conditions it was evident: (1) That the sewage should not be discharged into the Fond du Lac River without purification. (2) That a purification plant could not well be installed near the business center of the city where the greater portion of the sewage is discharged. (3) That sewage could not be delivered to a convenient place for purifying it by gravity. (4) That a pumping station was necessary, not only to deliver the sewage to some point where it might be conveniently purified, but also in order to maintain a free outfall for the sewers during high water, so that basements might be protected from flooding.

The general plan included a 24-in. intercepting sewer some 7,000 ft. long, laid at a sufficient depth to gather the discharge from all the old sewers which had formerly discharged into the river, and to deliver it by gravity to a point selected for sewage disposal, where it is lifted by pumps and passes through the purification plant. The effluent then flows to the main river by gravity, through about 1,000 ft. of 24-in. vitrified pipe. The purification works are in a sparsely settled part of the north central portion of the city.

The intercepting sewer, which has a grade of 1 ft. in 1,000 ft., is not designed with a capacity sufficient to discharge all of the storm water at the pumping station, but has a capacity of about 5,000,000 gallons each 24 hours. The present legitimate sewage discharge of the city of Fond du Lac is probably about 500,000 gallons per 24 hours, so the intercepting sewer will be ample for a very considerable growth of the city, so far as the discharge of house drainage is concerned, and will also intercept the washings from pavements during all light showers, and probably the greater proportion of the foul washings from the street surfaces during heavy rains.

The old sewer outlets into the East [illegible] of the Fond du Lac River were left intact [illegible] will serve as storm water overflows when [illegible] intercepting sewer becomes overcharged. W[illegible] the old sewers are connected with the in[illegible]cting sewer, manholes (Fig. 4) have been built [illegible]ided with a gate chamber in which is set [illegible]arge swinging check valve which permits th[illegible]ccess of storm water to escape and prevents [illegible]ack water in the river from flooding the intercepting sewer. The intercepting sewer at its upper end, which is in the business portion of the city, is laid at about the level of low water, so that these check valves may at times be under a back pressure of 5 or 6 ft. of water. At the pumping station the intercepting sewer is 7 ft. below low water. The bottoms of the overflow manholes are provided with sumps so that sand and gravel from the streets may be intercepted. The pumps and purification plant are still further protected by a grit chamber and screen, shown in detail by Fig. 5.

The intercepting sewer discharges into a pumping pit, Fig. 6, from which the sewage is elevated into the septic tanks. It flows from the septic tanks, Figs. 3 and 7, over a weir into a sewage carrier, from which it may be led to the contact beds or directly into the river.

The pumping machinery consist of one 5-in. and one 10-in. vertical, centrifugal Lawrence pump. The smaller pump is directly connected to a 10-HP. vertical motor, and the larger to a 35-HP. vertical motor. Both motors are compound

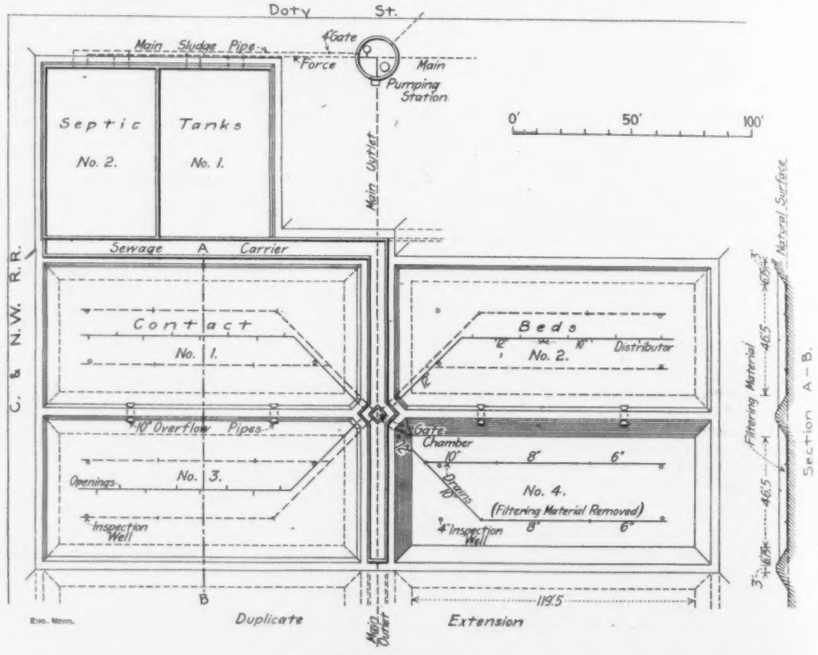


FIG. 3. GENERAL PLAN OF SEWAGE DISPOSAL WORKS AND SECTIONS OF CONTACT FILTER BEDS AT FOND DU LAC, WIS.

*Kalamazoo, Mich.

†Returns to "The Municipal Year Book" state that a suit for water pollution by sewage was brought against the city, but that it was dismissed. No further particulars were given.—Ed.

wound, were made by the Northern Electrical Manufacturing Co., of Madison, Wis., and are operated by an independent 500-volt circuit brought from the power house of the Fond du Lac Electric Co.

The speed of the 5-in. pump is 600, and of the 10-in. 400 revs. per min., and the corresponding capacities are 800 and 3,000 gallons per minute, or about 1,150,000 and 4,320,000 gallons per day. When the sewage rises to the desired level the trip engages the arm of the starting device and throws the switch which starts the motor. As the sewage falls, the alternate movement of the cable opens the switch in the same manner. The adjustment of these trips is such that the larger motor is only thrown into service when the volume of sewage discharged is greater than the capacity of the 5-in. pump. When the 10-in. pump is

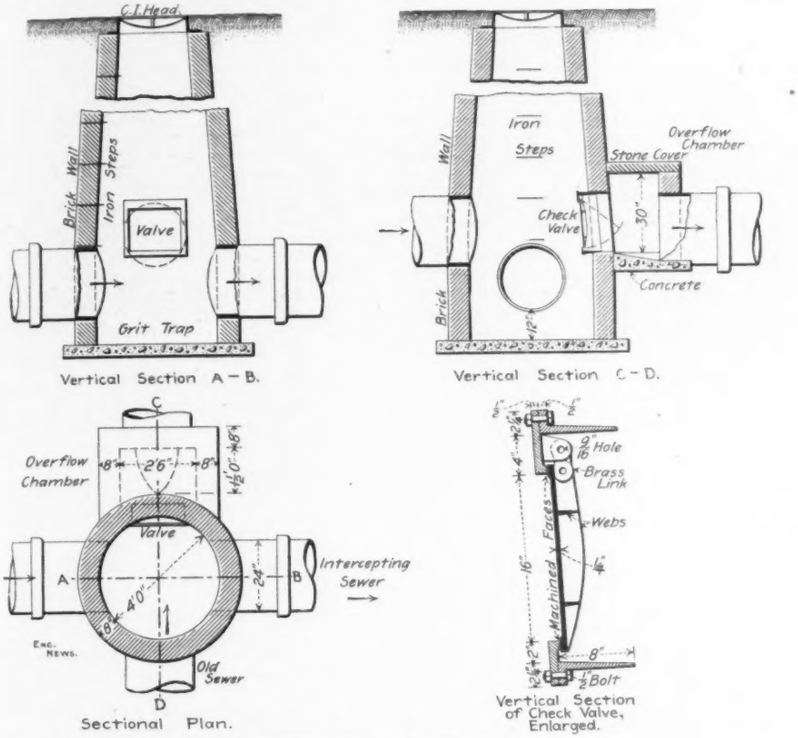


FIG. 4. STORM WATER OVERFLOWS IN INTERCEPTING SEWERS.

Each pump is set on cut-stone blocks bedded in the cement floor of the pumping pit, and is connected to its motor by vertical shafting and insulated flange couplings. An intermediate bearing is attached to an I-beam built into the pumping pit for that purpose. The pumps have marine thrust bearings, and these and their intermediate bearings are supplied with oil through ¼-in. pipes carrying sight-feed oil cups, which extend above the floor of the motor room. The pumps are of the bottom-suction type, so as to enable the level of sewage in the pit to be reduced to the lowest possible point without the pumps taking air. The motors are set upon the floor of the motor room. The 10-HP. motor is guaranteed to have an efficiency of 86.5%, and the 35 HP., 91.2% at full load. The armatures run upon ball bearings, which are adjustable so as to preserve the proper position of the pump impeller.

The arrangement of the pumping machinery and connections is somewhat novel. As ordinarily operated, the 10-in. gate which separates the two pumps will be closed, and, except during storms, the 5-in. pump will handle the entire sewage flow, pumping it directly into the septic tank. A 10-in. check-valve prevents the backflow of sewage into the pump pit when the pump is not running. This pump operates intermittently, being thrown into service automatically when the sewage in the pump pit has accumulated to any desired depth, and thrown out of service automatically at a point just high enough to prevent the pump from taking air. As ordinarily operated, the 10-in. pump will not be in service except during storms, when it is automatically thrown into and out of service in the same manner.

The motors which operate the pumps are thrown into and out of service by trips, which are fastened to wire cables shown in Fig. 6. One end of the cable is fastened to a float which rests upon the surface of the sewage in the pumping pit and to the other is attached a counterweight. thrown into service it discharges ordinarily directly into the outfall sewer, and from thence directly into the river, its discharge not passing through the purification plant.

Several other combinations are possible, however. Both pumps may discharge into the septic tank or directly into the river, and if the 5-in. pump should fail or should need repairs, the ordinary flow of sewage may be delivered to the purification plant by the 10-in. pump. Any desired proportion of the discharge of either pump may also be delivered to the purification plant and the balance to the river.

The motors are protected by fuse blocks and by automatic circuit breakers. The pumping machinery is entirely automatic in its operation and requires no attention more than the occasional filling of the oil cups.

In the motor room is a gage board on which the level of the sewage in the pumping pit is indicated by an index actuated by a float resting upon the surface of the sewage.

In testing the pumping plant there was an excellent opportunity to record the conditions of sewage flow by direct measurement, and to note the cost of pumping. The conditions were the more favorable for the reason that the soil in which the sewers of Fond du Lac are laid is a very retentive, red clay, and the infiltration of subsoil water, which in many cases interferes with the value of such determinations, was here very slight.*

The rate of flow for each interval during which the pump was idle was readily deducible from the diameter of the pump pit and the time required to fill it between given points. These records were taken by Mr. Irvine Watson, who was in direct charge of the construction of the plant, throughout one 24 hours, and the results are shown graphically by the diagram, Fig. 9. The minimum rate was 22.15 cu. ft. per min.; maximum, 35.28; average, 29 cu. ft. per min. The total discharge for the 24 hours was 312,365 gallons. The total power consumption for 24 hours, as indicated by the meter on the switchboard, was 31.5 K-W hours. The city pays 4¾ cts. per K-W.-hour for current, so the cost of power for 24 hours was $1.49.

Not all of the sewers of Fond du Lac are yet connected with the intercepting sewer. Probably about three-fourths of the sewage of the city is represented by the diagram. The small per capita discharge noted is due not only to exclusion of subsoil water, but in part to a limited water supply and high water rates.

Two heavy rains occurred soon after the plant was put in use, and the operation of the pumping plant and also of the storm overflow seem to be entirely satisfactory.

The connections between the pumps and the septic tank and the details of the latter are shown by Figs. 3 and 7. The mean dimensions of each tank are about 45½ × 69 × 8 ft., giving a capacity of 185,700 gallons each, or 371,400 for both, with no allowance for sludge deposits.

The walls and bottoms of the tanks are built of 1 : 3 : 5 Portland concrete masonry, and the roof is of tar and gravel, on a timber frame. The tanks are made as nearly air-tight as possible, and in the roof are set several inspection openings formed of wrought-iron pipe closed with a threaded cap. The gases from the tanks will be burned; primarily to avoid odor, but incidentally to produce light.

The sludge which accumulates in the bottom of

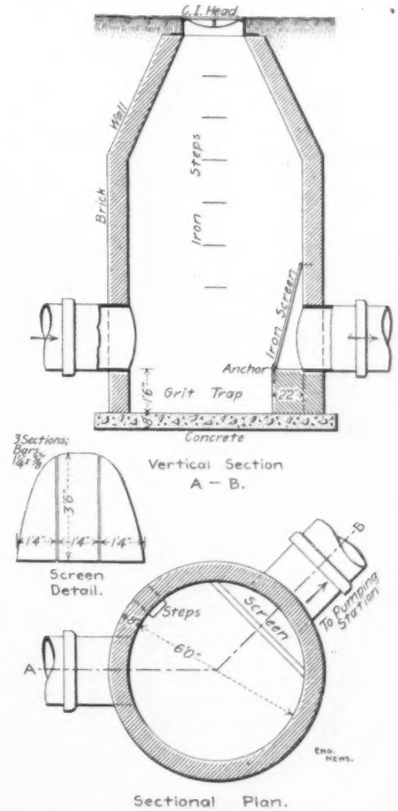


Fig. 5. Grit and Screen Chamber Near Sewage Pumping Station.

the septic tank will be largely mineral matter, and can be drawn off into the pumping pit and pumped to the river during freshets, or may be drawn off and removed through a 4-in. T-branch and coupling in the sludge pipe.

The effluent from each tank is discharged through twelve rectangular chimney flues, extending through the outer walls at an angle, as shown in Fig. 7. These outlets terminate just

*For instance, the infiltration of subsoil water in the intercepting sewer was measured after its completion and before the old sewers were connected with it, and, although it is laid below the level of low water, as previously stated, is 24 ins. in diameter and more than 7,000 ft. long, was found to be less than 8 cu. ft. per min.

behind a long weir, also shown in Fig. 7. That portion of the sewage carrier in front of the weir is filled with coarse cinders. It is expected that these cinders will form an intermediate step in the process of purification by assisting in the re-oxygenation of the sewage, as it flows from the septic tank, and will better prepare it for the changes which it should undergo in the contact filters. Probably the cinders will also assist in re-seeding the sewage with aerobic bacteria or will render more active this class of bacteria, which may have become comparatively inactive

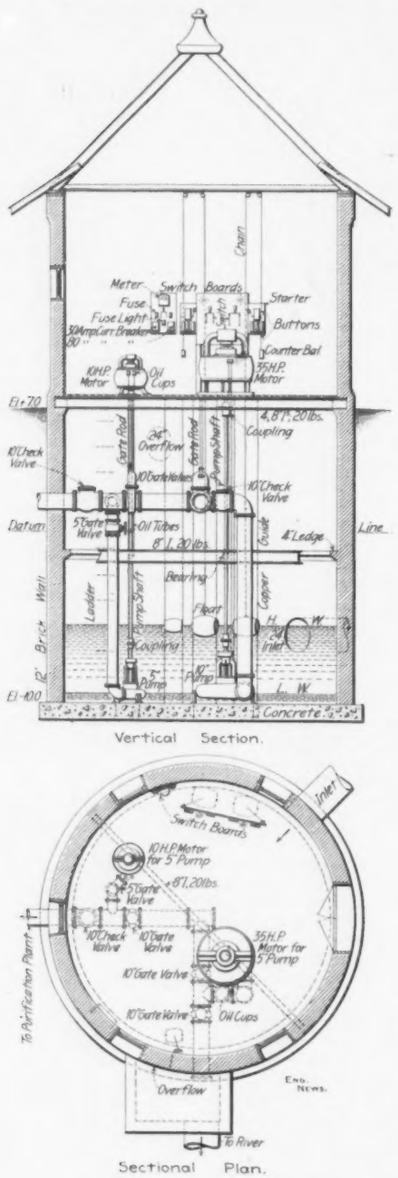


Fig. 6. Plan and Section of Pumping Station.

in the septic tank. The sewage carrier acts also as a collecting reservoir from which the sewage may be rapidly discharged into the contact beds.

The carrier is covered with planks set in jambs formed in the concrete walls. The gate house encloses the gate chamber. In no stage of the process is sewage in sight.

The sewage is discharged upon the contact beds by valves, which are situated in a gate house, Fig. 8, which is common to four of the beds. The gate chamber is built with an outer and an inner compartment. From the outer compartment sewage is distributed upon the contact beds and the drains leading from the contact beds discharge into the inner compartment, which communicates with the main outlet sewer leading to the Fond du Lac River. The beds may be filled through the distributors or through the drains or through both of these channels at once.

The contact beds are filled with screened cinders and have a working depth of 3½ ft. The beds are filled through terra cotta pipes laid with open joints and having 4-in. T-branches placed at intervals. These T-branch openings are graduated, so as to have an approximately equal discharge throughout the length of the distributor, by inserting disks with various sizes of orifices. The distributors are covered with cinders, and it is the intention to fill the beds only to a line a few inches below the surface of the cinders. Inspection wells are set in the contact beds so that the level of sewage in them can be noted.

The embankments of the contact beds are either of red clay well compacted, or have in them layers of red clay extending down to and uniting with a natural red clay stratum.

Each of the four beds has a surface area of about 7,400 sq. ft., thus giving a total area of 29,600 sq. ft., or 0.68-acre.

The contact beds are operated as follows: The sewage as it flows from the septic tanks is allowed to collect in the carrier until the carrier is full; the gates at the head of the distributing pipes which lead to the surface of the cinders are then opened and the accumulated sewage, together with what is constantly being added in the meantime, is distributed in one of the beds underneath the surface of the cinders until the bed is filled nearly to the surface. With the present flow of sewage this filling will require about 1½ hours. When the bed is filled to the desired level the valve is closed and the effluent from the septic tank is again held in the carrier until it is filled, when another bed is filled in the same manner. Each of the four beds are thus filled in rotation.

An overflow is provided in the carrier by making the wall of the inner compartment of the gate chamber slightly lower than the outer wall so that in case the attendant neglects to open, at the proper time, the gate which feeds the beds the carrier may overflow into this inner chamber and the sewage pass directly into the main outfall sewer.

When the beds are filled the sewage is allowed to stand in them for a time varying from one to two hours as seems most advisable. The purified sewage is then drawn off into the main outfall sewer through gates which control the discharge from the drains and open into the inner compartment of the gate chamber.

Gage boards will be set in an inspection well in each contact bed and an index above the surface of the bed, which may be readily seen from all parts of the plant, will indicate the level of sewage in the beds.

Frozen ground prevented the completion of two of the beds before winter, and delay in securing cinders still further postponed their completion. One of the septic tanks and two of the contact beds were put in operation on Feb. 11, 1902, and the other septic tank was put in use about a month later. At the outset, a few days were spent in filling and discharging the beds to remove snow and ice which had accumulated in the cinders, after which it was noted that the temperature of the sewage dropped about 2° F. in passing through the tank and contact beds; the temperature of air being about an average of 15° F.

The accompanying table of analyses, made by Mr. David Molitor, indicates a general improvement in purification, as the bacteria have time to become established.

It will be noted that the purification shown by the analysis of March 17 was less than that [illegible] by the previous analysis. This is due to [illegible] that just before this date the second sep[illegible] was put in operation and the proportion of [illegible] which was passed through it was not pu[illegible] the same degree as was that passing thro[illegible] tank which had been longer in operati[illegible] analysis of a week later shows an impro[illegible]

The appearance of the effluent from the [illegible] beds has been uniformly good. It has at all [illegible] been perfectly clear, so far as the eye can [illegible]

When fully completed and equipped the ap[illegible]

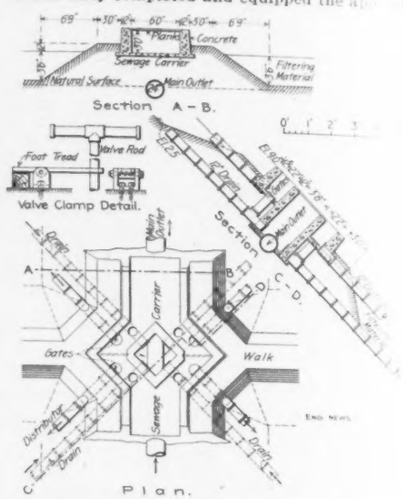


Fig. 8. Sewage Distributing and Effluent Receiving Chamber for Contact Beds.

mate cost of the work described will be as follows:

Intercepting sewer, $24,000; pumping station, $1,550; pumping machinery and connections, $2,950; disposal plant, $11,500.

The pumping machinery was erected by Mr. Edward Yeomans, Monadnock Block, Chicago; Mr. R. J. Bloedel, of Fond du Lac, was general contractor; and Harding & Nelson, of Racine, Wis., and Blake Bros., of Madison, were sub-contractors. Mr. Irvine Watson was local engineer in charge of construction.

THE NEW YORK RAPID TRANSIT COMMISSION'S PLAN FOR A SYSTEM OF INTERBOROUGH RAPID TRANSIT

At the meeting of the New York Rapid Transit Commission on May 15, its President, Mr. Alexander E. Orr, presented a communication advocating that steps be taken at once by the commission to

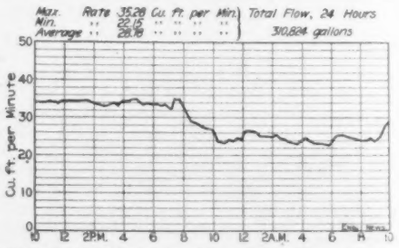


Fig. 9. Hourly Sewage Flow at Madison, Wis., Feb. 7 and 8, 1902.

(Probably about three-fourths of the total flow from the system reached the sewers on the date named.)

Analyses of Crude Sewage and of Effluents from Septic Tanks and Contact Filter Beds.*

		Ammonia					Per cent. purification.		Temperature, degs. F.	
	Date.	Free.	Albuminoid.	Oxygen consumed.	Nitrites.	Nitrates.	Chlorine	Alb'd ammonia.	Oxygen consumed.	Sewage.	Air.
Sewage	Feb. 26.	1.70	..	4.17	0	0	..	..	..	..	..
Bed	"	1.70	..	0.50	0	0	..	..	88.0	..	..
Sewage	Mar. 11.	2.10	0.54	8.00	0	0	13.6	..	..	42	..
Tank	"	2.00	..	2.90	0	0	..	..	64.0	42	..
Bed	"	1.32	0.10	0.46	Trace.	0	13.6	81.4	92.5	..	..
Sewage	Mar. 17.	2.50	0.20	4.62	0	0	12.2	..	..	42	7
Tank	"	..	..	2.88	0	0	..	..	37.0	41	..
Bed	"	1.80	0.05	0.58	Trace.	0.32	12.4	75.0	87.5	38	..
Sewage	Mar. 26.	2.00	0.16	5.07	0	0	14.0	..	..	44	49
Tank	"	..	..	2.96	0	0	..	..	42.0	42	..
Bed	"	1.80	0.10	0.53	Trace.	0.16	13.6	37.5	90.5	45	..

*The columns in the table have been rearranged and under percentage albuminoid ammonia removed has been added.—Ed.

prepare plans for a comprehensive system of rapid transit lines which would include all the boroughs of Greater New York. The importance of this communication has been briefly referred to in our editorial columns, and we shall review some of the possibilities more fully in a succeeding issue; owing to its interest as an item of news, however, we give the communication in full as follows:

The public has come to fully recognize the wisdom of development of the rapid transit facilities of Greater New York and of the use of its street property for rapid transit purposes upon a general and farseeing plan. Rapid transit franchises, it is now believed, ought to be granted with reference to a systematic treatment of the subject, under the guidance or initiatory control of a single body like this board, with a tenure sufficiently long to assure not only the adoption of a comprehensive programme, but also, at least in part, its execution. This idea was embodied in the present rapid transit act, providing as it did not only for municipal construction of new rapid transit railroads, but also for the grant of rapid transit franchises to companies operating existing lines.

The board is almost ready to advertise the contract for the Brooklyn-Manhattan extension already adopted. It has, at the request of the Mayor, begun the consideration of a comprehensive terminal system intended to include the present Brooklyn Bridge and the bridges Nos. 2 and 3, now under construction. It has received from the Pennsylvania Railroad Co., and is now considering, an application for the grant of a franchise for a tunnel railroad under the Hudson River, across the Borough of Manhattan, under the East River, and connecting in the Borough of Queens with the Long Island Railroad system. Under the amendment to Section 32 of the Rapid Transit act, and without further legislation, as I am advised, it will also be possible, with a co-operation of the city authorities, upon which, I believe, we may count, for the board, upon the application of the New York Central and Hudson River Railroad Co., to authorize an enlargement of the terminal facilities of that company so as to permit it to make the peremptorily needed change of motive power in the Park Ave. tunnel. I earnestly hope that such an application will presently be before the board.

It is, therefore, clear that the public now has a right to expect from this board the preparation of a general and far-reaching system of rapid transit, covering the whole city of New York in all its five boroughs. It was in anticipation of that work that the board, in January last, asked the Mayor and Controller for early information as to the extent to which the debt limit and other necessities of the city would permit rapid transit extension, in addition to the Manhattan-Bronx and Brooklyn-Manhattan roads. When that information shall be received the board will be better able to decide where the next rapid transit expenditure shall be placed.

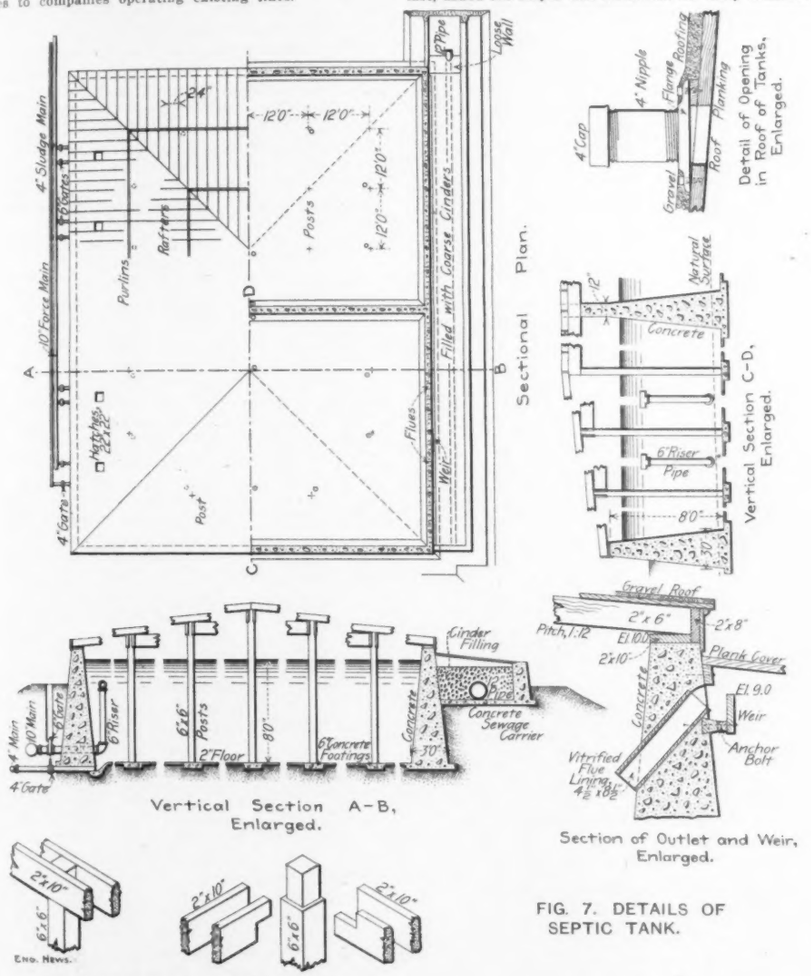


FIG. 7. DETAILS OF SEPTIC TANK.

Detail of Purlin and Post Connections, Enlarged.

When the present board took up the study of the problem its jurisdiction was confined to the present boroughs of Manhattan and The Bronx, and it then proposed a general plan, with a central route along Broadway to Fourteenth St., and from that point with direct extensions toward the northern limits of the city, one on the East Side along Fourth and Park Aves., and the other on the West Side along Broadway and the Boulevard. That plan was disapproved by the Appellate Division of the Supreme Court, chiefly upon considerations of expense; and the maximum limit of $35,000,000 which it was understood that the court might approve, compelled the board to place the point of departure of the East Side line from the main line as far uptown as 104th St.

When the plan now under construction was adopted the board was careful to announce that because of the constraint thus placed upon its action, it formed only a part of a more comprehensive system which the board intended to lay out as soon as the financial condition of the city should permit. In the hope that such financial ability is not far distant, the board instructed you at its meeting, held on the 1st inst., to submit plans for an East Side line connecting with the present rapid transit route at 42d St. and Park Ave. This instruction did not imply a determination of the board as to what should be the next rapid transit route adopted, but only that the necessities of the upper East Side would have to be studied and considered, as would also the further claims of Brooklyn and the claims of other boroughs.

The far-reaching plan I have suggested could not, of course, be carried out at once, or, perhaps, completely carried out, for many years. But if such a plan be now wisely prepared and the streets of New York be dedicated to tunnel railroad purposes, with a proper regard to the long, and, no doubt, splendid future of the city, two things may reasonably be expected. First, that rapid transit construction will proceed upon the lines so laid down as rapidly as the means of the city and the amount of private capital ready for rapid transit investment will permit. And, second, that relatively unimportant franchises will not be granted in such way, or special routes be so devised as to prevent or obstruct a permanent and sufficient programme.

The commission took action upon this communication by passing the following resolution:

Resolved, That this communication of President Orr, under date, May 9, 1902, be formally referred to the chief engineer with the request of the board that he prepare a comprehensive scheme of rapid transit as therein suggested.

In connection with this action of the Rapid Transit Commission it will interest engineers to know that the construction company now building and proposing to operate the portion of the rapid transit railway under construction in Manhattan has also offered to build and operate any extensions which the commission may decide to build. This offer was made in a formal letter to the Rapid Transit Commission dated Feb. 13, 1902. The letter was as follows:

Dear Sir: It is apparent from the most recent reports of the Controller, which have come to the notice of the Rapid Transit Subway Construction Co., that on account of the approximation of the city debt limit to the constitutional limit, the Rapid Transit Railroad Commission will not be able for a long time to do any more than authorize the Brooklyn extension, even if it can do that at an early day.

It appears to the Rapid Transit Subway Construction Co. that the development of rapid transit in New York city must necessarily suffer seriously and meet at the outset a check to its growth, which public sentiment would view with much disfavor.

The operating company, which will shortly be organized, representing the same interests as the Subway Construction Co., will be prepared to construct extensions and connections with its own capital and credit, provided the means and methods can be arrived at for doing so. I suggest as a plan approved by our executive committee that such extensions and connections can be built on bonds of such operating company, which necessarily will have to bear a higher rate of interest than the city bonds, convertible into city bonds at the option of your commission, the construction being in all details conducted precisely in the same manner as the present work is being done, and becoming a part of the system as a unit.

If this suggestion meets with your approval I shall be glad to appear at any time which may be agreeable to you before your board to discuss it more in detail. As the Rapid Transit act will probably have to be amended in some particulars in order to enable such plan to be carried out, and as the present session of the legislature will probably be a short one, I would suggest that the matter be taken up by your counsel in connection with ours, to determine in what respects such amendments should be made, and to frame and introduce a bill for the Legislature, always assuming that the general suggestion meets with the approval of your board.

Yours very respectfully,
August Belmont,
President Rapid Transit Subway Construction Co.

BOOK REVIEWS.

LOGARITHMIC TABLES OF THE MEASURES OF LENGTH; Extending from 0 to 50 Ft. at Intervals of One-Sixteenth of an Inch.—By Thos. W. Marshall. New York: Engineering News Pub. Co. Flexible leather; oblong; 5¾ × 3¼ ins. $2.

In his introduction to this book of tables the compiler says:

The following tables are presented to the engineers and draftsmen of the country in the belief that their general introduction would result in the saving of much labor in all operations of multiplication and division which involve fractional parts of feet expressed in inches and sixteenths. . . . All the tables have been carefully checked several times—both before and after they were set in type—and it is confidently believed that all errors of greater magnitude than one unit in the last decimal place have been eliminated.

The tables are arranged six columns on a page with the feet and inches in heavy-faced type at the top and the sixteenths in similar type in right and left-side columns. The opposite pages thus give all the fractions of a foot in inches and sixteenths. The logarithms are in all cases given to seven places of decimals.

TOPOGRAPHICAL RECORD AND SKETCH BOOK for Use with Transit and Stadia. By Daniel Lawrence Turner, Assoc. M. Am. Soc. C. E., Instructor in Surveying and Hydraulics, Harvard University. New York: Engineering News Pub. Co.; 5½ × 7½ ins.; stiffened linen covers; pp. 92. 75 cts.

This little book is the outgrowth of a communication published in our department of "Letters to the Editor," in our issue of April 25, 1901, by Mr. Richard G. Doerfling, of Pittsburg, Pa. This letter proposed a field book for stadia measurements, having alternate pages ruled with circles and radial lines for the convenient plotting of topography from stadia measurements. This publication developed the fact that a book of this sort had been devised by Prof. Turner, and had been used by his students in surveying. Further correspondence on the proposed book was printed in our issues of Aug. 1, Aug. 8 and Sept. 5.

In an introduction to the book the author suggests a form for keeping stadia notes, and gives a number of useful hints regarding methods of conducting work. Following the ruled pages are tables for reduction of stadia readings compiled by Arthur Winslow, M. Am. Inst. M. E. The book is made up with tough linen paper, each left-hand page is given horizontal and vertical ruling for the ordinary stadia notes and the facing page is ruled with concentric circles spaced ¼-in. apart and with radial lines 10° apart. The ruling is printed in light blue.

The size chosen is adopted with a view to convenient carrying in the pocket, and the corners are rounded for the same purpose. In general no pains have been spared to make the book a useful and practical aid to the field engineer, and we trust it may meet with appreciation.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

In a letter printed in our correspondence column, last week, the chairman of the Missouri Railroad Commission said: "The inherent limitations of the couplers in general use are so manifest that their discontinuance is practically conceded by the railways to be inevitable, sooner or later." We made such comment as we deemed necessary on this statement last week. As a further reply we would call our readers' attention to the Western Railway Club paper, printed on another page of the present issue, on the "Defects of M. C. B. Couplers." The author of this paper, who is Superintendent of Motive Power of the Burlington & Missouri River R.R., says: "There are probably very few who are familiar with the present coupler and its predecessor, the link-and-pin drawbar, who will seriously contend that the automatic coupler is not a great and decided improvement."

Concerning the paper itself, it may be remarked that it is a most interesting record and classification of coupler failures, both in the yard and on the road, and points clearly the way to further improvements in the direction of bettering the coupler. One of these improvements which has been frequently urged in these columns is closing the slot between the lugs of the knuckle. Fully half the yard breakages and a large per cent. of the failures on the road, are due to failure of the lugs, according to the showing made by Mr. Smith's statistics. The slot was a necessity when the coupler was adopted to permit connection with the link and pin during the transition stage, but it was always intended that the knuckle should eventually be made solid. In the interest of both economy and safety, the Master Car Builders' Association cannot act too promptly in ordering that all new knuckles applied to cars be made solid.

One of the most common difficulties of engineers engaged in reservoir construction is to make the slope-paving stay where it is put. With the soil on which it rests lubricated by the water, friction of the paving on its bed must often be reduced to a very low figure, and the great weight of the paving is concentrated to create a very heavy thrust at the toe of the slope.

To engineers who have experienced this difficulty, or who wish to guard against it in the design of works, we suggest consideration of the section of reservoir embankment adopted for a new reservoir at Aurora, Ill., and illustrated elsewhere in this issue. The banks of this reservoir have a concave slope on the water side. With a proper design for this concavity, it would seem possible to eliminate the concentrated thrust at the foot of the slope. Instead, the thrust would be carried around the curve of the slope and transmitted as a horizontal thrust to the bottom paving.

If any engineers have ever used such concave slopes for this purpose, we shall be pleased to have particulars concerning it. In the present case the concave slopes were not adopted for this purpose, as the reservoir in question is built in rock, and is to have a concrete lining. Moreover, the designing engineer informs us that he has never used such slopes before or seen them used. It appears to us, nevertheless, that the idea is one which is admirably adapted for reservoirs with earth banks protected by stone paving, and particularly where such paving has to be laid on a slippery clay. If any of our readers have arguments to present, either for or against such a construction, we shall be pleased to hear from them.

What is there that so marks the philosophic mind as contentment with one's lot? What a fine illustration of such philosophy is that much-talked-of public character, Col. John P. Gaynor. When circumstances which he could no longer control compelled him to leave the United States and take up his residence in Canada at an inclement season, no complaint was heard; instead he talked, in this cheerful strain, to a reporter of the "Syracuse Herald" not long ago,

> I'm feeling fine. Never better in my life. I like it here. There is no place in the world like Quebec. What better place could a man want to live?

Later, he spoke of the future. No gloomy forebodings; no crossing bridges till they were reached. This is the way he expressed his cheerful confidence:

> Why don't they do something? We are here ready to be taken back, why don't they come and get us if they can? Let them take us if they can. They can't do it. That's the reason and they know that they can't do it.

As most of our readers have already learned, circumstances have again interfered to change the habitat of this cheerful philosopher. On May 15 he and his co-conspirator Greene, were arrested and removed to Montreal, under an extradition warrant, and the atmosphere there is rumored to be much more chilly than in Quebec. Nevertheless, we doubt not that Col. Gaynor's philosophy will sustain him even in this hour of adversity. He will doubtless cheer himself with the reflection that if legal technicalities could delay for two years his extradition from New York to Georgia, it ought to be possible to stave off at least as long his extradition from a foreign country.

The New Orleans sewerage injunction suit, still unsettled, has brought about on unfortunate conflict of interests in that city. Briefly stated, the New Orleans Sewer Co., previous to 1895, built a portion of a proposed system of sewers. It then encountered financial difficulties, went into the hands of a receiver, and work was stopped. With the near completion of the surface drainage system, on which the city has been for some years at work, the necessity of completing the sewerage system is apparent. The New Orleans Sewer Co. claims that its franchise is still valid, and this claim is sufficiently backed by legal opinion to make a long litigation certain and the outcome problematical. Under existing conditions, the City Sewerage and Water Board, which is practically identical with the Advisory Board on Drainage, concluded that delay would be avoided and probably much money saved to the city by coming to an amicable agreement with the old sewer company to purchase all its completed work for a reasonable sum. It was certain that, if the franchise claims of the company were sustained the compensation demanded would be very large. To this end the city and the sewerage company each appointed an engineer to thoroughly examine the sewers already completed after they were pumped out.

These engineers, after making the examination, although they differed in their estimates of the value of the work in question, united in declaring that the completed sewers were in a stable and satisfactory condition as to alinement, level and materials used. On Dec. 15, 1900, the engineers of the Advisory Board also reported to the Sewerage Superintendent that the examination of these sewers "had given very satisfactory and gratifying results." They went on to say that this examination had demonstrated the fact that a large box-sewer, 20 ft. under the street surface, and small pipe sewers, 5 to 12 ft. below the same, could be so built as to remain in a stable condition in the peculiar soil underlying New Orleans. These engineers were Messrs. B. M. Harrod, Rudolph Hering, George W. Fuller, L. W. Brown and A. C. Bell, all men thoroughly familiar with conditions in New Orleans and intimately connected with the important engineering work in connection with the city's surface drainage.

But in the face of the facts here stated, and the evident wisdom of the course recommended by the Sewerage and Water Board, a bitter opposition to the proposed agreement with the sewer company has suddenly developed. This opposition is largely based on a denial of the sufficiency and stability of the sewers in question. Strange to say, Mr. L. W. Brown, who, as one of the engineers of the Advisory Board, signed the report above quoted, is seemingly at the head of this opposition. In any event, his testimony against the proposition is chiefly depended upon in the present suit. Mr. Brown is a voluminous writer, and the press of New Orleans is just now filled with his letters. In one of these communications Mr. Brown makes a gross and inexcusable blunder in supporting his contention by the following quotation from the minutes of the Advisory Board, of Dec. 3, 1900:

> It was the sense of the Board that they could not recommend the adoption of the old system as part of the new, except in so far as the size of pipes and the condition thereof may be found to be such as to make them available for incorporation in the new system.

The "Daily Picayune" points out that Mr. Brown erred in not quoting the whole of the minutes of that date. Had he done so, the full context would have shown that what he gave to the public as the opinion of the Advisory Board on the old sewerage system really referred to the physical condition of the New Orleans and Algiers Water-Works, and to the advisability of including in a new distribution system certain water pipes which had been in the ground for 35 to 70 years. The statement quoted above had no connection whatever with the subject of the present sewerage litigation, and the public were simply wilfully deceived.

As before remarked, this conflict of interests is unfortunate, and the conflict, at this distance, seems to be one of private interests against the public good. The present Advisory Board of New Orleans, under which about five million dollars have already been expended upon the drainage work, has so intelligently, faithfully and economically performed its difficult duties that the good citizens of New Orleans wish to retain their services in connection with the work on the proposed sewerage and new water supply systems. But another element has entirely different views in the case, and proposes, if possible, to oust the Board from its responsible and powerful position. The late attack upon Major Harrod, which so ignominiously but justly fizzled, was in the same line as this attack upon the sufficiency of the sewers which the present administration proposes

to utilize in the new plan. Judging from the evidence given in the present sewerage litigation, and from the methods of the opposition as exposed in the press, the best interests of New Orleans would call for the retention of the present Advisory Board in all matters relating to the other engineering work now contemplated. The importance and cost of the work proposed calls for an able and honest administration by public-spirited men, and having once secured an administration of that type, it is very bad policy to make a change.

The separation of oil from exhaust steam so that the condensation can be used over again as boiler feed water is a problem that has never been very satisfactorily solved. One reason for this is that very little has been known about the conditions to be met. We publish on another page of this issue the results of a very careful investigation of this matter, which gives more information upon it than has ever before been available. It appears from this investigation that the oil in exhaust steam is carried along in the piping chiefly in the condensation adhering to the sides and bottom of the pipe. The current of vapor in a horizontal pipe is almost absolutely free from oil. The author believes, therefore, that with a thorough system of pipe drainage, coupled, perhaps, with the use of mechanical oil separators on the exhaust main, it would be possible to use a large proportion of the condensed steam over again for the boilers without any treatment.

The extraction of the oil from the emulsion of oil and water collected by a pipe drainage system is a rather difficult problem, but the greatest success was obtained by the use of a coagulant, such as milk of lime. By treating the make-up water with milk of lime, and then combining it with the discharge from the pipe drainage system it would be possible to kill two birds with one stone, viz., reduce the hardness of the make-up water and remove the oil from the remainder of the mixture.

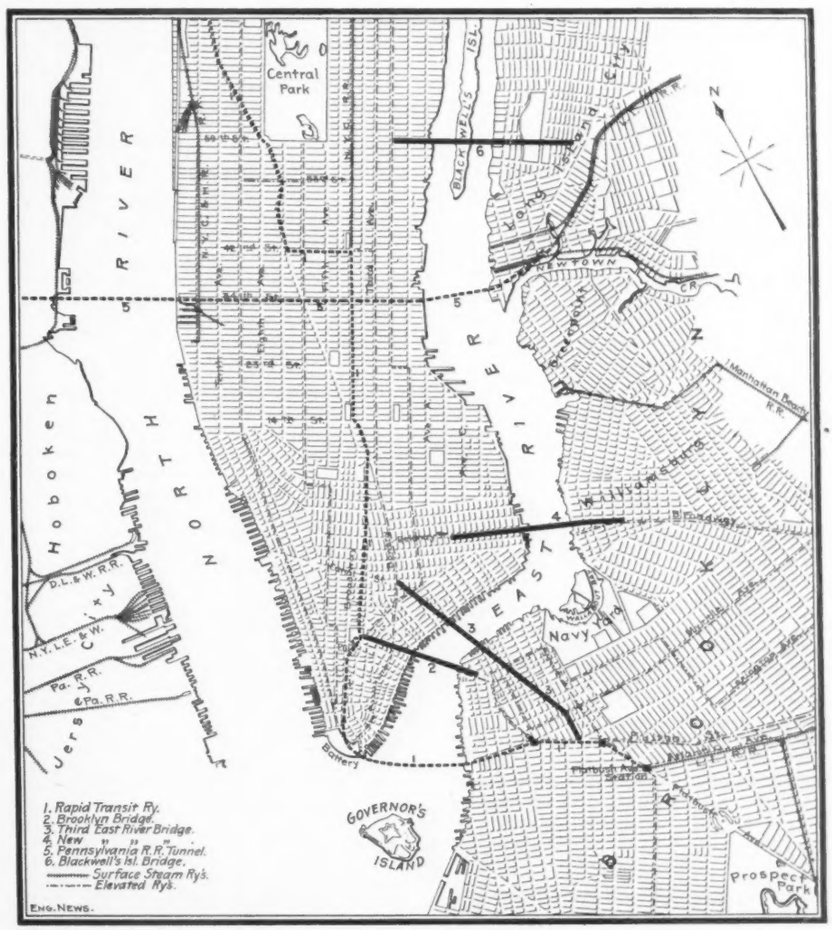
THE PROPOSITION TO ABANDON THE CONSTRUCTION OF THE THIRD EAST RIVER BRIDGE AT NEW YORK.

The effort made some three years ago to secure the substitution of one or more tunnels in place of the third suspension bridge, now under construction across the East River, has been renewed by a portion of the newspaper press of New York city. While we confess to but slight hopes that this reopening of an old controversy will accomplish any radical alteration in the present plans, it is so entirely justified by the circumstances as to demand more than the merely passing notice that would otherwise be its due. Indeed, so unwarranted is the expenditure of upward of $20,000,000 at the present time to construct this bridge, as to make one hope against hope that the work already done may be abandoned, even though a million dollars more or less has already been spent. It is never wise to throw good money after bad.

When the Third East River Bridge was first projected Engineering News questioned the necessity for its construction, and particularly the wisdom of locating it at the point just north of the existing Brooklyn Bridge, which was chosen for its site. At that time we took the position that it would be a much wiser policy for the city to encourage the construction of the tunnel which the Long Island R. R. was clamoring for permission to build from its Brooklyn terminus to the south end of Manhattan Island, and that the city should expend only what was necessary to run a tunnel under the East River to tap the populous district of South Brooklyn.

As our readers know, the passing years have brought a radical change in the conditions which then existed. Political opposition killed the Long Island R. R. tunnel extension, as is noted elsewhere in this issue; the South Brooklyn tunnel project, which then had good chances of life, has apparently expired of inanition. Meanwhile, it has to be particularly noted that the Third East River Bridge has been placed under construction, and there has already been expended upon it about $1,000,000. On their face these circumstances remove the strongest reasons which formerly existed for combating the construction of the Third East River Bridge. They do not comprise the entire record of events, however. While the Long Island R. R. tunnel and the South Brooklyn tunnel are defunct enterprises at present, their place has been taken by other plans for East River transit whose actual construction is one of the certainties of the near future.

To summarize briefly the present conditions, the New East River Bridge, which has been under construction since 1896, is now approaching completion. Further north, work is in progress on a great cantilever bridge across Blackwell's Island, and a few years will see its completion. The abandoned Long Island R. R. tunnel has been replaced by the Rapid Transit Railway tunnel extension to Brooklyn, which is practically certain to be in operation before the Third East River Bridge can possibly be completed. Finally, a great tunnel connection across Manhattan Island has been provided for to join the Pennsylvania R. R. in New Jersey with the Williamsburg terminal of its recently acquired Long Island system. The accompanying sketch map shows the location of these several bridges and tunnels in relation to the location of the Third East River Bridge.



SKETCH MAP SHOWING EXISTING AND PROPOSED BRIDGES AND TUNNELS ACROSS THE EAST RIVER AT NEW YORK CITY.

With the map before us, let us restate in another way the conditions just described. Route No. 2, the present Brooklyn Bridge, is already in operation; routes Nos. 1, 4 and 6 are practically certain to be completed and in operation within from two to four years. The future of route No. 5 is less certain, but it is entirely possible that that portion of it connecting Manhattan and Long Island, were it begun at once, would be in operation within the same period of time. Neglecting this last-named route entirely, however, we have the following conditions, namely, that before any structure of the dimensions and type of the Third East River Bridge can be completed, there will already be in operation three bridges, and one double-track railway tunnel for taking passengers across the East River between Manhattan and Brooklyn. The Third East River Bridge has, however, been planned and placed under construction. These actions mean, if they have any meaning at all, that the city authorities responsible for them believed that within a year or two after the three bridges and one tunnel enumerated above are in operation there will be urgent need for another route for transporting passengers across the East River; that this route should be a bridge costing upward of $20,000,000, and that this bridge should furthermore be located as shown by route No. 3 on the map. Let us so far as we can test the truth of these assumptions.

Is there reason to think that within five years there will be sufficient traffic across the East River to occupy the facilities of five transportation routes, each with a capacity equal to that of the present Brooklyn Bridge? It will be observed that this is what the present provision for the Third East River Bridge assumes. Now, we are not aware that there are any statistics of East River traffic which warrant this assumption. It is true that the accommodations of the present Brooklyn Bridge are very much overcrowded, but this bridge actually carries in some fashion all the land traffic across the East River. Let us assume that it carries daily twice as many passengers as it should reasonably be required to accommodate, and let us assume further that within five years the total land traffic across the East River will be twice that now carried by the Brooklyn Bridge. We believe that these assumptions are beyond the truth, but will let them stand for the sake of illustration. In five years, then, the traffic across the East River will be sufficient to furnish a reasonable traffic to four structures

like the Brooklyn Bridge. The present plans of the city propose to make five such structures available, one more than by the most liberal count is necessary.

To proceed a step further let us grant that after the Blackwell's Island Bridge, the New East River Bridge and the Rapid Transit Railway tunnel are open to traffic, there will still be an unaccommodated traffic demanding facilities for crossing the East River. There are two ways in which this traffic may be accommodated; another bridge may be built or one or more additional tunnels may be constructed. Each of these plans has its advocates among engineers and in the original controversy referred to in our opening paragraph the arguments of each side were presented in some detail. For the purpose of comparison we quote the summary of the opposing arguments which we then published as follows:

To back up the opposition against the proposed bridge plans and to support his plans for tunnels as a substitute, Comptroller Coler secured expert reports from Mr. Wm. B. Parsons, M. Am. Soc. C. E., Chief Engineer New York Rapid Transit Commission, and from Mr. J. Vipond Davies, one of the engineers of the East River Gas Tunnel, and of the projected Long Island R. R. tunnel. Summarized very briefly, these reports maintain the following general propositions: (1) Tunnels possess the important advantage of being cheaper to construct and maintain than bridges; (2) tunnels require no purchase of expensive real estate for approaches, as these can be located on city property underneath the streets; (3) as tunnels do not require the purchase of costly real estate they can be run anywhere, even directly across the city, and so connect with every intersecting transportation line; (4) the gradients on the approaches are descending in the case of tunnels and ascending in the case of bridges, and trains can therefore be started more quickly and operated more economically in the former case; (5) tunnels can be built more quickly than bridges; they give a better foundation for railway tracks and permit higher speeds; they can be made perfectly dry and free from fog and weather conditions; (6) the material beneath the East River is rock or compact soil, which are especially suitable for tunnel construction; (7) several tunnels can be built for the cost of one bridge, and can be distributed at several different points along the river front, thus better accommodating the traffic.

The arguments offered by the engineers of the Department of Bridges against tunnels and in favor of bridges may be briefly summarized as follows: (1) Subaqueous tunnels, such as would be required under the East River, would be purely experimental, both in respect to the execution of the work and their operation; (2) it would be almost impossible to construct such a tunnel so as to render it dry; (3) it is practically impossible to locate a tunnel under the East River having a grade that would permit train traffic, and at the same time have a terminal at any reasonably accessible point on Manhattan Island; (4) to furnish the same traffic capacity as the New East River Bridge would require six 15-ft. tunnels and two 28-ft. tunnels, which would cost more to construct than the bridge; (5) tunnels are wholly unfit for the use of teams and pedestrians.

As the reader will infer from what has already been said, the city authorities approved the contention of the Building Department and ratified their decision to build a bridge instead of a tunnel.

Let us inquire briefly what these arguments of the bridge engineers amount to. In view of the various submarine railway tunnels constructed in the past and now in constant operation, the first and second statements made come very near being absurd on their face. The third statement is worth hardly more consideration than the first two, but it may be observed from our map that neither the engineers of the Rapid Transit Railway nor those of the Pennsylvania R. R. appear to foresee the great objection pointed out in this statement. Arguments four and five, however, deserve a more lengthy study.

The traffic across the East River is essentially a long distance passenger traffic. It is made up nearly wholly of the travel of people who live beyond walking distance from the various river crossings, and who must, therefore, travel by railway to and across them. This is the paying traffic which a bridge or a tunnel line must depend upon for its support. The team traffic is almost wholly a river front traffic. It employs animal power, and for this reason will seek the shortest and easiest routes and those making the least demand upon the strength of the draft animals. For obvious reasons ferries are far better suited to handle traffic of this class than are either bridges or tunnels. As for the pedestrian traffic, it is trifling in amount and is rigidly limited by distances to a small area tributary to each crossing. In reality, then, we need to provide only enough tunnels to accommodate the railway lines which would naturally use a bridge on the same site. The Third East River Bridge is designed to carry four trolley railway tracks and two elevated railway tracks. At most, therefore, only three double-track tunnels are required to replace the railway accommodations on the Third East River Bridge, and we can safely guarantee, we think, that they can be built at no greater cost than that bridge. From the traffic point of view these tunnels have the great advantage over a bridge that they may be distributed at three different points along the river front, and so disperse instead of congesting the traffic. For example, one of them could be made to supply the crying need for a direct route to South Brooklyn, which is unprovided by any of the routes now projected and under construction.

Before going further with the consideration of the possibilities of additional tunnel lines and the best method of securing their construction, let us study for a moment the location which has been adopted for the Third East River Bridge. Upon looking at the map it will be seen that this bridge will receive its Brooklyn passengers at practically the same points as do the Brooklyn Bridge and the Rapid Transit tunnel extension, and that it will deliver these passengers in Manhattan at practically the same point as does the New East River Bridge. It will, therefore, be the most direct route only for those passengers who begin their journey south of the Brooklyn Navy Yard and end it north of Canal St. in Manhattan. Now the great bulk of the passengers from Brooklyn end their journeys south of Canal St., and for them the natural routes are the New East River Bridge, the Brooklyn Bridge and the Rapid Transit tunnel. To conclude, therefore, even if a Third East River Bridge is to be built, the location selected for it is open to severe criticism.

So far we have confined ourselves strictly to a criticism of the plans for constructing the Third East River Bridge, and we think that we have shown that the city is nowise justified by the conditions now existing in expending upward of $20,000,000 for such a bridge. Indeed, we believe that upon the showing so far made the city would be fully warranted in abandoning this costly structure and pocketing the loss of the expenditure already made. There are, however, far stronger reasons for abandoning the Third East River Bridge than any that have been yet given. As we note elsewhere in this issue, the Rapid Transit Railway Commission has taken action looking toward a complete system of interborough underground rapid transit lines. Furthermore, reputable capitalists have expressed the desire to build and operate these lines at their own expense as fast as they are authorized by the commission. The full details of the action taken by the commission, and of the proffered aid of private capital, are given elsewhere as we note above, and they need not be repeated here. The only point to be noted here is the scope and adequacy of the proposed plans. They provide not only for the construction of new routes in any direction and to any quarter of Greater New York, as occasion demands, but they embrace all existing routes and their future improvement. To summarize the plans of the Rapid Transit Commission, provide a system of rapid transit for Greater New York, not only for five or ten years to come, but for all time and not merely for the present crowded districts of Manhattan and Brooklyn, but for all the boroughs to their utmost limits. The proposition of Mr. Belmont and the capitalists back of him eliminates the debt limit obstacle which has always been the millstone around the neck of the commission in its endeavors to provide a logical and comprehensive rapid transit system. Altogether no more important and interesting announcements respecting the matter of rapid transit have ever been laid before the people of New York than those from Mr. Alex. E. Orr and Mr. August Belmont which we print in another column.

In a succeeding issue we shall point out some of the possibilities which these announcements suggest in the way of future rapid transit lines. At this time we shall, therefore, only note that in view of the facts which have been presented, it seems almost incredible that there should be any doubt of the wisdom of abandoning work on the Third East River Bridge. Indeed, to persist in making an expenditure of $20,000,000 or more to construct this bridge will be a flagrant misuse of public money.

LETTERS TO THE EDITOR

The St. Petersburg Bridge Competition.

Sir: Many of the foreign engineers and architects taking part in the competition for designs for a permanent palace bridge in St. Petersburg, as advertised by the St. Petersburg municipal council, have written to the municipal board expressing a desire to be acquainted with the character of the locality and of the architecture of buildings adjoining the site of this bridge. The St. Petersburg Municipal Board, therefore, begs leave to request you to reproduce in your journal the accompanying photographs for the convenience of your subscribers.

J. Krukow, Member of the Municipal Board.
Nicetas Neluboff, Secretary.

St. Petersburg, April 2, 1902.

(As the photographs would be of direct interest only to those taking part in the competition we cannot take space for their reproduction. They are open to inspection, together with the maps and profile of the site, at the publication office of this journal.—Ed.)

THE PHILADELPHIA MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The 82d meeting of the institute, which was held in Philadelphia from May 13 to 16 inclusive, was one of the largest and most enjoyable meetings it has ever held. The plan of numbering the badges given to members and guests and of printing a list of the names and numbers, which was inaugurated by the Mechanical Engineers' Society many years ago, has been adopted by the institute, and the last printed list showed that 302 members and guests were in attendance. The program of papers to be presented was a formidable one, no less than 38 being listed, but most of these were read only by title, not yet being printed, and others which were printed were taken as read.

1. Presidential Address by E. E. Olcott, New York city.
2. Biographical Notice of Clarence King, by R. W. Raymond, James T. Gardiner, S. F. Emmons and James D. Hague, New York city.
3. The Use of Ordinary Cameras in Accurate Photographic Surveying, by Howard W. Du Bois, Philadelphia.
4. The Cement Industry, by Richard L. Humphrey.
5. The Development of the Bessemer Process for Small Charges, by Bradley Stoughton, New York city.
6. The Effect of Re-Heating Upon the Coarse Structure of Over-Heated Steel, by Karl F. Göransson, Sandviken, Sweden.
7. Steel Rails: Relations Between Structure and Durability, by Robert Job, Reading, Pa.
8. The Oil Fields of Texas, by Robert T. Hill, Washington, D. C.
9. The Metallurgy of Titanium, by Auguste J. Rossi, New York city.
10. Specifications for Steel Forgings and Steel Castings, by William R. Webster, Philadelphia, Pa.
11. The Present Situation as to Specifications for Steel Rails, by William R. Webster, Philadelphia, Pa.
12. Puddled Iron and Mechanical Means for Its Production, by James P. Roe, Pottstown, Pa.
13. The Original Southern Limit of the Pennsylvania Anthracite, by B. S. Lyman, Philadelphia, Pa.
14. The Calculation of the Weights of Castings with the Aid of the Planimeter, by Clarence M. Schwerin, New York city.
15. The Camp Bird Mine, Ouray, Colorado, and the Mining and Milling of the Ore, by C. W. Purington, Brookline, Mass., and Messrs. Thos. H. Woods and Godfrey Dovetonn, Ouray, Colo.
16. Basaltic Zones as Guides to Ore Deposits in the Cripple Creek District, Colorado, by E. A. Stevens, Victor, Colorado.
17. Igneous Rocks and Their Segregation (Differentiation) as Related to the Occurrence of Ores, by Josiah Edward Spurr, Constantinople, Turkey.
18. Lode Structure at Cripple Creek and Kalgoorlie, by T. A. Rickard, Denver, Colo.
19. Diatom Earth in Arizona, by William P. Blake, Tucson, Arizona.
20. The Tombstone, Arizona, Mining District, by John A. Church, New York city.
21. The Mineral Crest or the Hydrostatic Level Attained by the Ore-Depositing Solutions in Certain Mining Districts in Great Salt Lake Basin, by Walter P. Jenney, Salt Lake City, Utah.
22. The Mining Industry of the Coeur d'Alene, Idaho, by James Ralph Finley, Colorado Springs, Colo.
23. The Old Rossie Lead Mines, by C. H. Smyth, Jr., Clinton, N. Y.
24. Silver Mining and Smelting in Mongolia, by Yang Tsang Woo, Tientsin, China.
25. Gold Mining in McDuffie County, Georgia, by W. H. Fluker, Tatham, Ga.
26. Notes on the Cost of Hydraulic Mining in California, by William E. Thorne, Georgetown, Cal.
27. The Gold Fields of the State of Minas Geraes, Brazil, by Herbert Kilburn Scott, Leeds, England.
28. Notes on Brazilian Gold Ores, by Orville A. Derby, Sao Paulo, Brazil.
29. The Manganese Industry, by E. G. Williams, Colon, Republic of Colombia.
30. The Reactions of the Ziervogel Process and their Temperature Limits, by Robert Henry Bradford, New York city.
31. An Improved Furnace Bottom, by Henry A. Mather, New York city.
32. The Effect of Tellurium on Brass, by E. S. Sperry, Bridgeport, Conn.
33. Determining the Size of Hoisting Plants, by Edward B. Durham, Trenton, N. J.
34. Tests of Impact Water Wheels, by Prof. R. C. Carpenter, Ithaca, N. Y.

35. Some Principles Controlling the Deposition of the Hydrocarbons, by George I. Adams, Washington, D. C.

36. Remarks Upon the Theory and Practice of Valuing Mines, by H. D. Hoskold, Buenos Ayres, Argentine Republic, South America.

37. The Auditing of a Mining Company's Accounts, by Charles V. Jenkins, Rossland, British Columbia, Canada.

38. Growth of Pig Iron Production During the Past Thirty Years, by John Birkinbine, of Philadelphia.

The first session was held in the lecture room of the Manufacturers' Club, in Walnut St., on Tuesday afternoon. After a short address of welcome by Mr. John Birkinbine, president of the Franklin Institute and ex-president of the Institute of Mining Engineers, the secretary, Dr. Raymond, made a most eloquent address on the life of Clarence King, the eminent geologist, recently deceased. This was followed by a paper on "The Use of Ordinary Cameras in Accurate Photographic Surveying," by Mr. Howard W. Du Bois, which was illustrated by lantern slides. Then came a paper on "Puddled Iron and Mechanical Means for Its Production," by Mr. James P. Roe. This paper described a new style of puddling furnace which the author expects will make puddled iron at as low a cost as steel can be made by the open-hearth process.

As is well known, the old puddling process, invented by Cort over a hundred years ago and improved by the boiling process of Rogers about 1836, depends for its success upon the use of a great deal of manual labor. The work demands great strength and a high degree of skill. About 25 or 30 years ago many different mechanical puddling processes were invented, one of which, the Danks revolving furnace, seemed for a time to offer great prospects of success. About 1876 a large plant of these furnaces was operated in Pittsburg, and a few years later another installation was operated in Cincinnati. Since then, however, the introduction of mechanical puddlers has ceased, and the puddling process itself has been largely abandoned on account of the continual cheapening of the production of steel.

Puddled or wrought iron, however, has always been considered a superior metal to steel for some purposes, especially for the work of the ordinary blacksmith, since it is less apt than steel to be injured by overheating, lends itself better to welding, resists corrosion better and takes and retains better a coating of zinc or of paint.

The new puddling furnace of Mr. Roe may be briefly described as a shallow rectangular box of cast iron, lined with magnesite brick, about 20 ft. long by 8 ft. wide, supported on trunnions and provided with gear so that it may be rocked through an angle variable at the will of the operator. It is covered with a fire-brick roof and is heated by oil or gas fuel. About 4,000 lbs. of melted pig iron is run into it, a bath of melted cinder having been previously made, and the silicon, carbon and phosphorus are oxidized by the oxidizing flame and by additions of roll scale. The bath is oscillated on the trunnions, the melted metal rolls down the bottom and is suddenly arrested at the end of the furnace, and this rolling to and fro is continued until the metal "comes to nature." The angle of oscillation is then increased and the pasty mass subjected to a similar rolling until it assumes a cylindrical shape, when one end of the furnace is opened and it rolls out onto a hydraulic squeezer of special construction, by which it is converted into a bloom.

A furnace of this kind has been operated successfully on charges of from 2,500 to 3,500 lbs, the average duration of a heat being 48 minutes. It is expected that such a furnace will make from 27 to 32 tons of rolled slabs or blooms in 24 hours. The product has been rolled directly into finished bars without repiling, and their quality has been found equal to the best reworked iron. It is expected by the author that in a properly designed plant of furnaces and squeezers, slabs and billets will be made at a cost per ton not exceeding that of ordinary steel.

The paper was discussed by Messrs. J. F. Wilcox, W. R. Webster, Dr. Raymond and President Olcott.

The evening session began with the presidential address by Mr. E. E. Olcott, which was a discussion of some of the features of the great problem of trusts which concern the engineering profession, and especially of the tendency of the managers of the trusts to impose secrecy as to methods of manufacture on all their technical staff. The following is an extract:

> The master minds in monopolies are too apt to see safety in secretiveness, being content to let well enough alone; they forget that it is to the young and subordinate men who have time, strength and opportunity to study details that they must look for radical improvement. The young men being restricted in their liberty of publication lose one great incentive to effort. They themselves may not advance to their full capacity, or may secretly resent the curb on liberty of full speech and look for the first chance for changing employment. It is lamentable how many young men holding important trade and manufacturing secrets are eager for a chance to go into new companies. It does not augur for the best that the great corporations detract from the aspirations of the young scientists. Publicity is certainly a spur to progress. Competition is the life of trade. Give to your professional peers results and receive from dozens or hundreds of them details of what they have done. We are not making these reflections in any but the most kindly spirit. It is not from lack of charity or ultra-conservatism alone that the results noted spring, but largely from the high pressure under which the master minds of the day are working.

The address of the president was followed by a paper on "The Cement Industry," by Richard L. Humphrey, which was illustrated by lantern slides. It traces the history of the manufacture of lime, mortar and hydraulic cement from the earliest times, in Egypt about 4350 B.C., down to the present date, and discusses the different methods of production of cement that have prevailed at different times. A similar historical and technical description of the manufacture of cement was given in our editorial in Engineering News of July 26, 1900. The following is an abstract of a portion of Mr. Humphrey's paper, showing the present status of the cement industry:

> From a small business, representing an investment of several hundred thousand dollars having a production of about 335,000 barrels per annum, it has grown rapidly in the last ten years, until now it represents an investment of over $65,000,000, and an annual production of 12,711,225 barrels—while this country has advanced from one of the smallest to one of the largest cement producing countries of the world.
>
> The production of natural cement attained its maximum of 9,868,179 barrels in 1899. This enormous production has not been equalled by any other country; in the last few years, however, there has been a decided falling off in the production.
>
> While it is true that the consumption of Portland cement has been growing at a very rapid rate, yet we may be said to be just on the threshold of a new age, the age of cement.

At the conclusion of Mr. Humphrey's paper it was announced that the rest of the evening would be devoted to a "camp fire" of the veteran members, to be held in the lecture room, at which reminiscences of the early days of the institute would be indulged in, and to an informal reception in the other rooms of the club, with music, dancing and a collation. The camp fire proved the greater attraction to even the younger members and the lecture room was filled with listeners to the speeches of three veterans, Dr. Raymond, ex-Secretary Thomas M. Drown and Edmund C. Pechin, one of the earliest vice-presidents of the institute. President Olcott, by request, then gave a brief account of his visit a few years ago to the islands of Martinique and St. Vincent, the scene of the recent volcanic eruptions.

The next day, Wednesday, was devoted to an excursion to the Edison Cement Works, near Phillipsburg, N. J. We will defer a description of this trip and of the works to our next issue.

In the evening a joint session of the institute and of the Franklin Institute was held at the club. Two papers were presented by oral abstract, and illustrated by drawings, lantern slides, viz.: "The Development of the Bessemer Process for Small Charges," by Bradley Stoughton, of New York city, and "Steel Rails: Relations Between Structure and Durability," by Robert Job, of Reading, Pa. The first paper gave the history of many of the so-called "little Bessemer" processes, including the Clapp-Griffiths, Robert and Tropenas processes. The many commercial failures of the little converters were described, and their causes given. One of the members of the institute, who several years ago had invested heavily in the Clapp-Griffiths process, humorously objected to the paper as being a violation of the article of the Constitution of the United States, which forbids "cruel and unusual punishments."

Mr. Job's paper is probably the most valuable contribution that has yet been made on the subject of the wearing power of steel rails. We shall reprint this paper in another issue. It shows that the durability of a rail is related not only to its chemical analysis, but also to physical structure, and that this can be controlled in the manufacture by freeing the steel from oxides and slag, and by proper heat treatment.

On Thursday morning a session was held at the Manufacturers' Club, for the presentation of two papers by Wm. R. Webster, "Specifications for Steel Forgings and Steel Castings," and "The Present Situation as to Specifications for Steel Rails."

In the first paper Mr. Webster reviewed the specifications for steel forgings and castings which have been formulated by the American Section of the International Association for Testing Materials (Eng. News, July 21, 1901), and reprinted together with these specifications a table from a paper by C. H. Ridsdale, read before the British Iron and Steel Institute in September last (Eng. News, Oct. 3 and 10, 1901), giving the "manifestations, classified under heads of faults of different types appearing after treatment by the user, for tracing their probable source." The following is an extract from the paper:

> We have passed through a period in which the chemical composition of steel has received the greatest prominence; but failures of steel forgings and castings of the best chemical composition have shown that we could not control the quality of the finished product by the chemical composition alone. It must be admitted that differences in the physical properties of the steel, greater than those due to small variations in composition, are produced by heat treatment, both in connection with the mechanical work of forging and otherwise. The present result is a strong tendency to deem the heat treatment more important than the chemical composition. I think the mean course is the safer. We should give them equal importance; for we know that to produce the best results we must start with a good uniform material, and employ also, under intelligent supervision, the best methods of manufacture and subsequent working.
>
> The annealing of forgings and castings is much neglected. The manufacturers who are doing the highest class of work for our government and other customers, under rigid specifications, assert that all such work should be annealed. Other manufacturers of a cheaper class of work claim that annealing is not necessary, and, in some cases, even go so far as to say it is injurious. They adduce results to prove their assertions. But it is only necessary to repeat the annealing under proper conditions, to prove that the source of such alleged injury was in the method of annealing used. In many cases, attempts are made to anneal forgings that have been finished at too high a temperature, without first allowing them to cool down below the critical point. This is merely slow cooling, and makes the material much worse than it would be if allowed to cool in the air.
>
> In consideration of such controversies, I would suggest that discussion be directed towards the heat treatment of steel, with an endeavor to decide some of the disputed points, and thus to improve the methods of manufacture.

The discussion of the paper did not point out any way for improving the manufacture of steel, but was confined principally to a criticism of a part of the specifications relating to the "yield point" and the "elastic limit." The opinion was expressed that it is useless to specify elastic limit when it was fixed at only one-half of the ultimate strength, since all commercial steel which fills the specified requirements as to ultimate strength elongation and contraction will always show an elastic strength at least half the ultimate, and one member said he had not used the elastic limit in a specification in over 15 years.

The paper on steel rail specifications discussed the recent progress by committees of different societies in trying to reach a standard specification. The paper concludes as follows:

> The next step will be for Committee No. 1 of the American Section of the International Association for Testing Materials to take up for consideration the modifications of its specifications made at Chicago, and report them at the annual meeting in Atlantic City, N. J., on June 12, 13 and 14, 1902. A cordial invitation will be extended to the members of all committees and associations who have discussed these rail specifications to attend and take part in the discussion. There is little doubt that the modified specifications will be approved by the American Section.
>
> I have stated the present situation in detail, because the subject is one of the most important now before us, and contributions from all quarters will be pertinent, useful and welcome. The work thus far done will naturally form a basis for the new Rail Committee of the American Society of Civil Engineers, which has been directed to report a form of rail specification covering both the manufacture and the inspection of rails. That body will, no doubt, improve on the present specification, and bring matters up to date in every particular. When this has been done, the other societies will, no doubt, accept the result; and it is not too much to expect that we shall soon have in use American standard rail specifications reflecting credit upon all who have assisted in this important work.
>
> Since the International Railway Congress meets at Washington, D. C., in 1904, there is no time to lose in the matter. The presentation on that occasion of such specifications, expressing a general agreement in American theory and practice, would, without doubt, greatly influence the action of the congress in this department.

After the adjournment of the morning session the members and guests went by trolley cars to the University of Pennsylvania, where an excellent luncheon was served in Houston Hall by the Students' Club of the university, and a meeting was then held in the spacious lecture room of the hall. An address was made by Dr. Edgar F. Smith, Vice-Provost and Professor of Chemistry in the university. Dr. Raymond then announced that a professional session would be held for the discussion of papers relating to other metals than iron and steel, but that those who were not interested in these papers were free to visit the different buildings of the university, the botanic garden, aquarium, etc. The great majority of the audience then left the lecture room, and divided into small parties in charge of guides, were conducted through the buildings and grounds. It was announced that a new engineering building, to cost not less than $500,000, was now under construction, so that the engineering department of the university will soon rank among the leading schools of its kind in the country.

On Thursday evening a reception was given to members and friends of the institute in the Academy of Fine Arts. After an hour spent in promenading through the picture galleries an excellent collation was served on the lower floor, after which, whether on account of fatigue or in accordance with Philadelphia custom, the reception came to an end at the early hour (for New Yorkers) of 11 p. m., so that there was not enough time for any one to meet every one he wished to meet. That opportunity was however afforded on the steamboat excursion the next day.

Friday was devoted to a trip on the Delaware River. The steamboat left Arch St. wharf at 9.45 a. m. The first place visited was the ship yard of Cramp's Shipbuilding & Engine Co., where several large steamships were seen in various stages of construction. The yard is a vast one, and there was time only for a rapid walk through it. To those who had visited it before there was nothing particularly novel to be seen. Next to the vessels themselves and the din of hundreds of pneumatic hammers, the most noticeable thing was the immense traveling cantilever crane located between two vessels, with its two long arms stretched over them, serving each of the vessels with material.

Leaving Cramps the boat went down the river to the League Island navy yard, where the U. S. cruiser "Minneapolis" was inspected, the ram "Katahdin" and an old style monitor were seen, and a rapid visit was made to some of the shops. League Island is a splendid site for a navy yard, and the government has recently made a large appropriation for improving it by the erection of new shops and docks. The chief objection to it seems to be

the mosquitoes and the malaria, the product of the marshes in its vicinity, but by the recent method of exterminating both by the use of petroleum, and a proper system of drainage, it is to be hoped this objection will soon be removed.

Leaving Cramp's the boat went down the river to the Park on the New Jersey shore, nearly opposite, which is a summer resort for Philadelphians. There we witnessed the operation of drawing in a large seine filled with shad and herring, and the tossing of them into a fishing sloop by a dozen fishermen. We were then taken to a large pavilion and given a fine luncheon, the principal course being planked shad. There is probably no finer meal known than a dinner of planked shad served in the open air on the bank of the river where the fish is caught, especially when there is a jolly and hungry party to eat it.

The remainder of the afternoon was spent in a visit to the ship yard of the New York Shipbuilding Co., just south of Camden. This is the newest and probably the finest ship yard in the world, having been in operation only about a year. Instead of the ships being built in the open air, as at Cramps, they are under cover, in a splendid tall building, large enough to hold six ships at once, and provided with overhead traveling cranes just like a large machine shop. Alongside of the stocks on which the ships are built is a large open slip big enough to hold two big steamships, also enclosed in a building open at the river end, and provided with a traveling crane. Here the boats after launching can receive their engines and boilers from the shops which are part of the works. These shops are built at right angles to the ship houses, and are of vast extent. All of the operations of building a ship are carried on under cover, in marked contrast to the method of other ship yards, where much of the work is done in the open air. All of the buildings are served with electric cranes, by which the material is handled with a minimum of labor. They comprise shops for shearing, bending and punching plates and structural shapes, for forging, boiler making, engine building, etc. Many special machines are in use, one of the most novel being an angle-bending machine. The several angle beams and other shapes used in a ship require to have the two legs bent at various angles, from highly acute to very obtuse. This bending is accomplished by a machine with rollers which are set at different angles as desired. The pieces are heated in long cylindrical heaters built of sheet iron lined with fire brick, and fired with three or four coal-fired furnaces, set at different points in the length. The bent angles which are imperfectly finished by the rolls are rapidly clamped to a large flat table, and the angles mauled by wooden mallets into the exact shape desired, as tested by iron templates. An instance of the rapidity with which work is carried on in the riveting shop was seen in the building of a plate girder, where two men operating a pneumatic riveter set ten ¾-in. rivets in a minute, or as fast as an active boy could pick up the hot rivets and put them into their holes. After spending an hour and a half in the works we returned to the steamboat and reached Philadelphia at 5.30 p. m. Thus ended one of the most instructive and successful meetings ever held by the institute.

ARTIFICIAL NITROGEN COMPOUNDS are the most recent achievements of electrochemical industry. The Atmospheric Product Co. will erect a factory at Niagara Falls, where an experimental plant has been in operation for some time. During the recent visit of Lord Kelvin to this country he inspected this plant, among others, and was deeply interested by it. The process involves the formation of nitric oxide from the nitrogen and oxygen of the atmosphere, by the agency of high-potential electric sparks. From this gas nitric acid or nitrates are obtained by direct reaction on water or other substances.

NEW TIE-PRESERVING PLANTS.

A tie-preserving plant for the zinc chloride or burnettizing process, and having a capacity for treating 2,000,000 ties per year, is now being built at Carbondale, Ill., for the Ayer & Lord Tie Co., of Chicago. It will have eight cylinders or retorts, 6 ft. 2 ins. inside diameter and 125 ft. long; six of these are to be put in at once. They are double ended, so that the green ties may be put in at one end and drawn out at the other; or they may be worked in and out from the same end. The cylinders have a pitch or sag of 2 ins. at the middle, where the main run-out is located, for drawing off the solution, while a plate across the bottom at each end (slotted out for the track rails) prevents the escape of any solution that may remain in the bottom when the doors are opened. The cylinders are covered with heat-insulating material, and have the doors supported by rods from the roof and cast-iron tracks on the floor. They are equipped with superheating coils inside to keep the temperature above the vaporizing point, while a vacuum is maintained to extract the sap from the ties. Each cylinder will hold 14 iron cars, each with 30 to 40 ties, according to size. The buildings are of brick, with steel roof trusses, in order to have the plant as fireproof as possible. The main building is 115 × 123 ft., the retort room being 90 × 123 ft., with a 25-ft. pump and machinery room at one side. The retort room has steel roof trusses, with a single line of intermediate columns. The floor is of concrete, with pedestal supports for the cylinders, and the piping will be laid between these pedestals, where it will be readily accessible for inspection or repair. The boiler house is also of brick, with steel roof trusses, and contains six tubular boilers, 6 × 18 ft. Provision will be made for storing a coal supply sufficient for ten days. A special feature of the plant is the adoption of electric power for handling material, there being eight double-drum electric hoists.

The tracks for the storage and shipping yards will be laid out by the Illinois Central R. R. The cylinders are being built by the Allis & Chalmers Co.; the boilers by the National Boiler Works, and the structural steel work by the Kenwood Bridge Co., all of Chicago. The total cost of the plant will be about $175,000, exclusive of yards and tracks. The plant is expected to be in operation by October. The zinc chloride or burnettizing process will be used, being applied largely to inferior timber, such as red oak and black oak, but other processes can be used if desired. The company has a ten-year contract with the Illinois Central R. R. for the supply of 25,000,000 ties, including treated ties and untreated white oak ties. Another plant is to be built by the same company at Grenada, Miss., which will be arranged for treating ties by both the zinc and the creosoting processes. Mr. W. W. Curtis, M. Am. Soc. C. E., Monon Building, Chicago, is the Consulting Engineer for both these plants, as well as for the new tie-preserving plant of the Mexican Central Ry.

THE ATLANTIC AVENUE IMPROVEMENTS OF THE LONG ISLAND R. R. IN BROOKLYN.

Contracts have been let and construction begun to remove the tracks of the Long Island R. R. from the surface of Atlantic Ave. in Brooklyn, N. Y., by means of a combination of subway and elevated structures aggregating 5.2 miles in length. Since 1877 the main tracks of the Long Island R. R. have occupied the center of Atlantic Ave., from the point of its junction with Flatbush Ave. in Brooklyn, east its whole length. At every street which crosses Atlantic Ave. [illegible] is a grade crossing, and although these [illegible]ings have been fenced in and guarded by gates they have been a hindrance to traffic and a constant source of danger, which have involved the railway company in annoying litigation for many years. In 1897 the city of Brooklyn began steps to solve the difficulty, and after much [illegible] a solution was evolved which was concurred in by the railway company. The history of the work and its outcome were fully outlined in our issue of May 18, 1899, and they will not be considered here except to repeat that the plan evolved provided, first, for the removal of the grade crossings from Atlantic Ave., and, second, for the construction of a tunnel from the present Flatbush Ave. station of the railway to a terminus in the lower part of New York city.

With this much done there followed another long delay. The railway company announced its readiness to begin construction and asked the city to grant it the necessary empowering legislation. For various devious reasons this legislation was delayed from time to time until public patience was exhausted and the railway company abandoned further efforts in disgust. Meanwhile the contract for the New York Rapid Transit Railway was let and agitation was begun to secure its extension to Brooklyn. This extension was finally decided upon and one of the effects of the decision was to cause the Long Island R. R. to abandon its proposed tunnel line to Manhattan. At the same time it began studies looking to a modification of its original plan which should retain the Atlantic Ave. improvement as originaly planned and substitute, in place of the original tunnel line, a connection with the Rapid Transit Railway extension from New York. It is according to this general plan that work is now in progress. Briefly summarized, this work includes the depression of the present passenger and freight terminals and the removal of the grade crossings from Atlantic Ave. by means of suitable viaduct and subway structures.

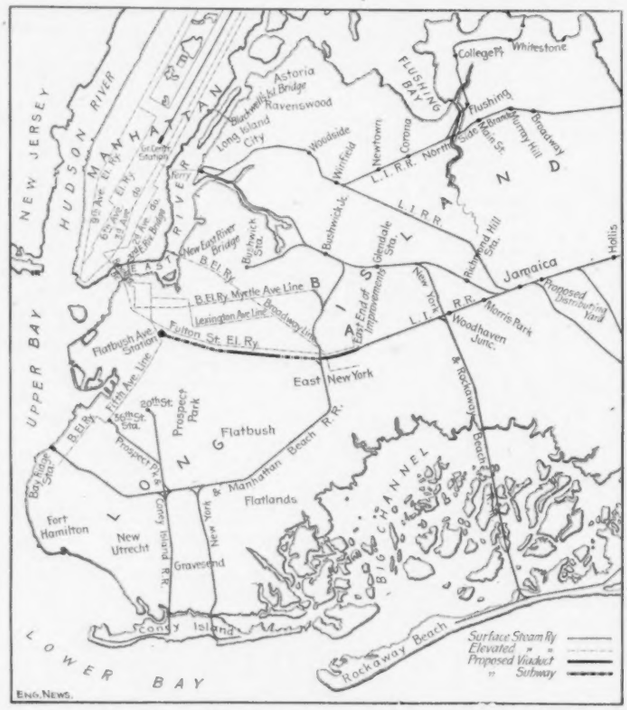


FIG. 1. MAP SHOWING ATLANTIC AVE. IMPROVEMENT OF LONG ISLAND R. R., BROOKLYN, N. Y.
J. Vipond Davies, M. Am. Soc. C. E., Chief Engineer.

DEPRESSION OF TERMINALS.

The present passenger terminal of the Long Island R. R. is at the junction of Flatbush and Atlantic Aves. From this terminal the main line of the road follows Atlantic Ave., running east. A few blocks east of the passenger terminal and to one side of the main line tracks are located the freight terminals, known as the Carlton Ave. Freight Yards. These yards are reached from the main line by a short spur track. Both the passenger terminals at Flatbush Ave., and the Carlton Ave. Freight Yards are to be depressed.

At Flatbush Ave. the work consists in constructing a depressed terminal embracing the whole area of the present surface terminal. To permit the construction of this depressed terminal the present yard and approach tracks and the present buildings and platforms are to be underpinned to permit traffic to be maintained during the progress of excavation. After the excavation is completed the existing depot and station buildings are to be permanently underpinned and supported in their present position on steel columns and girders. The floors are to be reconstructed of steel beams with suitable brick or concrete arches between them and the upper surface finished with a ce-

ented surface. The existing end platforms outside of the buildings are to be similarly supported and floored to form a gallery platform. The present yard tracks are to be lowered to the bottom of the depressed yard and between these platforms are to be built consisting of concrete or brick face walls filled between with earth and covered with a cement floor. These depressed platforms are to be connected by stairways with the gallery platform above. In the baggage depot the surface and depressed platforms are to be connected by elevators. The various platforms are to be roofed over, and it is possible that the railway company may decide to roof over the entire depressed terminal. The present yard track appliances and structures, the signal plant, etc., are to be reconstructed at the new yard level, and the present fencing is to be re-erected on the coping of the retaining wall which encloses the depressed yard. Finally, a short approach subway is to connect the depressed yard with the main line subway on Atlantic Ave.

The Carlton Ave. Freight Yards are to be depressed in a manner exactly similar to that described for the passenger terminal; the depressed area is to be inclosed by retaining walls and all the buildings are to be underpinned to form a basement story whose floor is to be connected with the street floor by elevators. A short subway provides for the spur track from the main tracks on Atlantic Ave. to the yard tracks.

ATLANTIC AVENUE IMPROVEMENT.

As already stated, the main tracks of the Long Island R. R. will be removed from the surface of Atlantic Ave. and carried on viaduct and in subway for a distance of about 5.2 miles. Starting from the Flatbush Ave. terminal there will be first a stretch of subway, then a stretch of viaduct, then another stretch of subway, and finally a concluding stretch of viaduct. The transition between the subway and viaduct will be accomplished by open cut and masonry abutments. At one point, namely, between the second stretch of subway and the final stretch of viaduct, the tracks for a short distance will remain undisturbed in order to give access to adjacent freight yards, but at all other points within the limits of the improvements, the tracks will be removed from the street surface by subway or viaduct construction. The sketch map, Fig. 1, shows the alternation of subway and viaduct construction which has just been outlined.

SUBWAY CONSTRUCTION.—For all the subway work the standard subway construction shown by Fig. 2 will be employed. This subway structure consists of an invert of concrete between vertical concrete side walls, which carry a roof of transverse I-beams with 5 ft. concrete arches between them. It is so located that its center line comes about 4 ft. to one side of the center line of Atlantic Ave. At intervals of 30 ft. along the center line of the avenue there are ventilator wells leading from the interior of the subway to the street surface. The side walls have at intervals of 15 ft. refuge niches for the shelter of trackmen, and at intervals of 900 ft. large special niches are employed, in which to install the electro-pneumatic signals for train operation. The side walls contain throughout their whole length embedded ducts for electric wires, and at intervals there are manholes in which these ducts terminate, and by means of which the wires are introduced and withdrawn when occasion demands. All of these standard constructions are shown in detail by Fig. 2.

Taking up the construction in more detail, it is specified that the floor of the subway shall be built first and after the excavation is completed. This floor is an inverted arch, 12 ins. thick at the center and increasing in thickness toward the ends. Along its center is a drain composed of two parallel walls of concrete made up at the same time and forming part of the invert construction and covered with flag stone; weep holes are introduced in the bottoms of these walls at intervals. At each side of the drain there is a filling of stone ballast to carry the railway tracks. The side walls of the subway, except where niches and manholes occur, are solid concrete walls, except for the vitrified electric wire ducts. The specifications stipulate that they shall be built with a finished cement face rammed in place on the inside as the wall is built up, and that their backs shall be stepped and left rough. At intervals of about 5 ft. along the tops of the walls iron bearing plates are bedded firmly in the concrete to carry the steel roof beams. The roof of the subway consists of steel I-beams varying from 24 to 30 ins. deep, according to the depth of permanent cover over the roof resting on the bearing plates and having concrete arches between them. The concrete filling between the roof beams comes above these upper flanges and is crowned so as to slope each way from the center line of the ventilator wells. On top of the concrete there is a waterproofing layer covered with a coat of cement plaster. The construction of this waterproofing and its plaster covering is described as follows in the specifications:

When masonry has thoroughly set and after it has dried out under a warm sun and to the satisfaction and approval of the engineer, it will be swabbed over with hot melted "medium hard" coal tar pitch of a somewhat softer grade than used for roofing purposes, or such as will soften at a temperature of 90° F., and melt at a temperature of 100° F., being a grade of pitch in which distillate oils, distilled therefrom, shall have a specific gravity of 1.105. This pitch shall be poured or mopped on top of the arch concrete until it has a perfectly uniform thickness over every part of not less than 1-16-in. Immediately upon the first coat of pitch, and while it is still melted, there shall be laid a covering of single-ply roofing felt of quality as hereafter specified, and the laps of roofing felt shall be at least 4 ins. on all cross-joints, and at least 12 ins. on all longitudinal joints. Immediately after laying first thickness of roofing felt, there shall be again mopped a uniform coating of pitch as above specified, and upon that again a second thickness of one-ply roofing felt, and thereupon a third coating of not less than 1-16-in. thick of coal tar pitch. All joints in both plys of felt must be lapped as above specified. The waterproofing shall extend over the ends and down on the vertical sides of subway construction as shown in the drawing, and the vertical waterproofing shall be in every respect the same as the top waterproofing. The roofing felt to be used in waterproofing shall consist of pure wood paper pulp or asbestos pulp which has been thoroughly treated and soaked in refined coal tar, and which weighs, for single ply, at least 15 lbs. per 100 sq. ft. After the waterproofing with pitch and felt has thoroughly set and hardened, there shall be spread thereon and carefully and uniformly over every portion thereof with plasterer's trowel, a layer of plaster 1 in. thick of Portland cement mortar which must be laid in uniform squares in every respect similarly to the plaster of top surface of granolithic pavement. The squares will be about 5 ft. square, and when one square is set the adjacent squares will be laid up tight to it; this laying out in squares being for the purpose of relieving contraction and expansion in the plastering coating. This plaster coating must be protected from injury and from any working or walking thereupon, until thoroughly hardened, after which the necessary fill may be made up to grade for the street pavement or for street surfacing.

The transverse sections, Fig. 2A, show the construction which has been described. They also show the location and general character of the niche construction, the manholes, and the ventilator wells. These special structures merit more extended mention, however, and they will now be referred to in detail. Taking first the manholes, it will be seen from the plan and elevation, Fig.

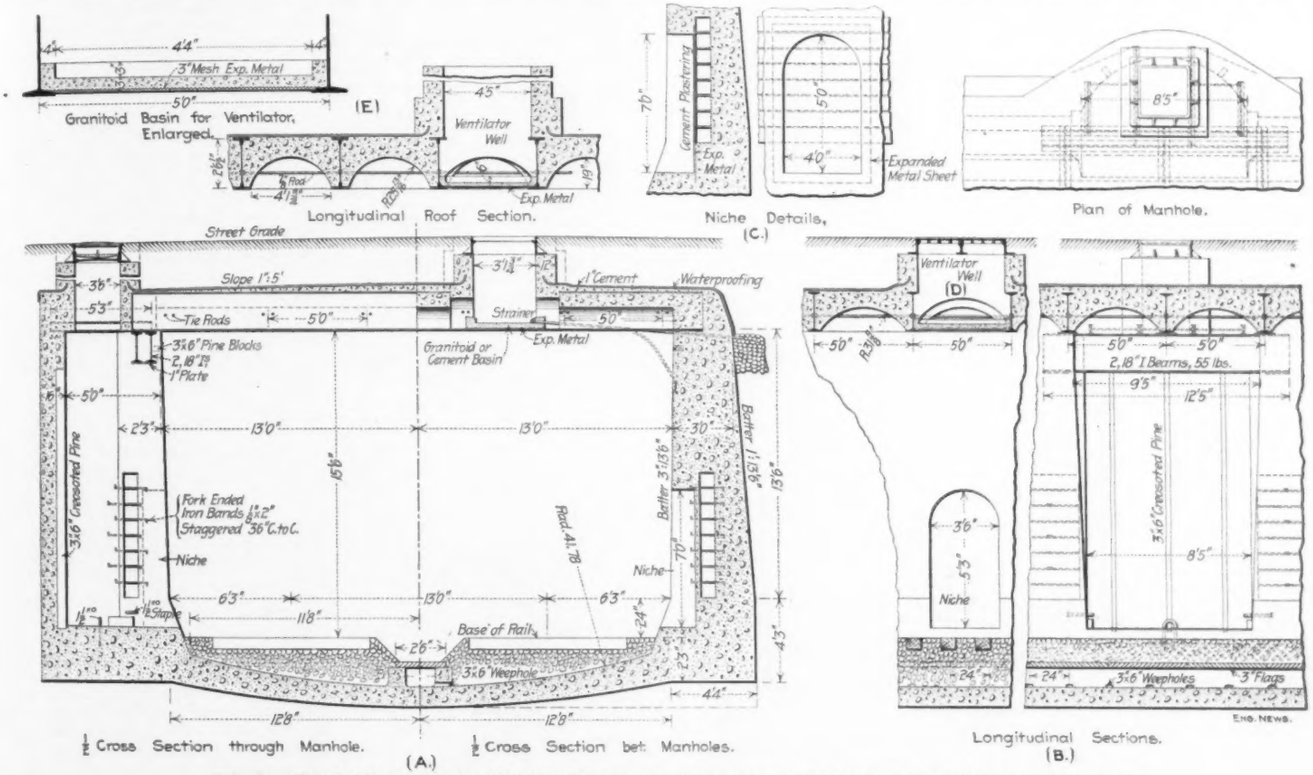


FIG. 2. STANDARD SUBWAY CONSTRUCTION, ATLANTIC AVE. IMPROVEMENT OF LONG ISLAND R. R.

2B, that they are local enlargements of the side wall to form niches or chambers 8 ft. 5 ins. wide and 5 ft. deep, into which the electric wire ducts open, and which give access to these ducts. All of these chambers open into the subway, and all but five have manhole shafts opening out onto the street surface. The opening in the subway side wall made by these chambers is spanned by a double I-beam girder to carry the ends of the subway roof beams and in the rear wall of the chamber are embedded timber strips. The remaining details can be obtained from the drawings, Fig. 2, A and B. The specifications for the electric ducts or conduits which open into the manholes are in abstract as follows:

These conduits will be of hard-burned, salt-glazed vitrified brick. They shall be true to form and perfectly straight. They will be of whatever form and pattern the engineer may adopt, either single duct or four duct conduits. In any case the duct holes must be not less than 3¾ ins. nor more than 3⅞ ins. diameter or square with the corners rounded, and holes must be throughout smooth and free from rough particles of dirt, burnt clay or glaze. The lengths of vitrified ducts shall not vary from the standard length specified and adopted by more than 1½% above or below. This same limit of allowable variation in length shall also apply in the case of special lengths ordered. All conduits must be free from fracture, splits and all defects of any kind.

Ends of duct holes will be slightly bell-mouthed. In case four-hole conduits are adopted there will be dowel holes left at each end, and contractor shall, when erecting same, insert iron dowels, with central washer, into the dowel holes in each joint, for truly centering the sections. Wooden stoppers shall be placed in the free ends of all ducts when the work is left at night, when sections are completed or at other times when required. In erecting conduits, the sections must be kept in perfect alinement throughout, and wooden mandrils, 3 ins. diameter and not not less than 4 ft. long, shall be threaded through the holes and remain in place until the surrounding masonry has set solid. These mandrils shall have fitted to the ends a spring steel tube scraper with flue brush behind same for thoroughly cleaning out any foreign matter existing in the duct. Butt joints of conduits shall be broken at every tier half the length of section, or as may be specially required by the engineer. Every butt joint shall be lapped around with two laps of No. 6 cotton duck canvas, burlap or cheese cloth, 6 ins. wide, laid 3 ins. on each abutting section, and the canvas, burlap or cheese cloth shall be dipped in neat Portland cement grout immediately before lapping. At each manhole short length conduits are to be furnished and used, in order to effect proper breaking of joints, as above required. These short length sections, either for breaking joints or for making closures, shall be cut cleanly and truly square butts and without splitting of the ducts in any way. Special care shall be taken in joining cut and short lengths to keep them truly in line and so that no unevenness or roughness exists on the end joints. No single short length conduit shall be less than 12 ins. long. The standard length of conduit adopted will be 36 ins. long, but, if required by the engineer, the contractor shall furnish specially prepared lengths or types, either for working around curves or for efficiently making closures. In the case of conduits set in the body of concrete subway sidewalls, between each alternate tier of conduits and about 36 ins. center to center and staggered, there shall be laid on flat, a flat iron bond 2 x ¼-in.] ard length as shown on drawings, split and forked, at each end to connect the face and back portions of sidewalls. Every tier of conduits is to have a layer of Portland cement mortar laid on top, in which the next tier is to be bedded, even and fair. In filling concrete or other masonry around conduits the same must be worked up evenly on each side so that no distortion of any kind may occur in the finished conduit.

As previously stated, the subway sidewalls are pierced at intervals by niches. The standard refuge niche is shown in elevation and section by Fig. 2, A and B. These refuge niches are spaced 15 ft. apart, c. to c. At intervals of 900 ft. there are also special niches for signal installation larger than the refuge niches constructed, as shown by Fig. 2 C. It will be noted that the depth of these special niches leaves but a thin partition between their rear walls and the electric wire conduits, and that this partition is reinforced by embedded expanded metal.

The construction of the ventilators, which are placed 30 ft. apart, c. to c., along the subway roof, is shown by Fig. 2, A, D and E. These ventilators are rectangular shafts reaching from the interior of the subway to the street surface, with a grating at the top and a basin at the bottom for catching any water which may drip from the grating. As will be seen from the drawings, this drip basin is a shallow vessel made of granitoid with embedded expanded metal, and carried on the lower flanges of the roof beams between which the shaft extends upward. Access of air into the shaft from the subway is afforded by the spaces between the intrados of the roof arch and the top edge of the basin as indicated by the arrows in Fig. 2 A. The drainage of the drip basin is effected by the galvanized iron drain pipe, shown in Fig. 2 A.

The concrete used for the subway structure is required to conform to the following specifications:

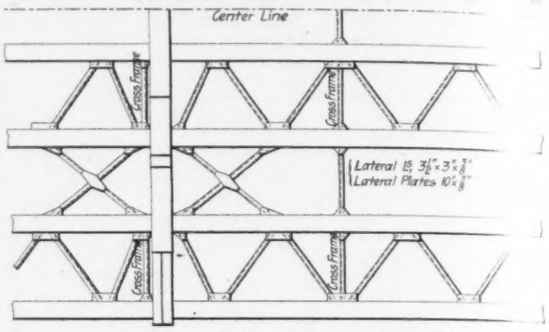
Concrete in massive construction, such as retaining walls, column foundations and inverts (where such are used), will usually be proportioned: 1 part by volume of Portland cement, 8 parts by volume aggregate of stone, gravel and sand; in "jack arches" of roof and side walls and any other construction in which the thickness of the work is less than 18 ins. (excepting inverts as above specified), 1 part by volume of Portland cement, 6 parts by volume aggregate of stone, gravel and sand.

The top portion of foundations for columns of viaduct structure and any other portion of the work where a heavy concentrated load will be put upon the concrete, shall be constructed for a depth of 9 ins. beneath the steel plates, and the exposed surface of concrete walls and abutments shall, at the same time backing is deposited, be faced not less than 2 ins. thick with concrete proportioned: 1 part by volume of Portland cement, 5 parts by volume aggregate of crushed rock, gravel and sand; in which no portion of aggregate shall be larger than will pass through a ¾-in. mesh screen, and in such proportions as to make an aggregate free from voids. All concrete, wherever used, either in subway sections of the improvement construction or in foundations for viaduct columns, or elsewhere, must be mixed by power machines unless specific permission to the contrary is given by the engineer; in which case the mixing shall be in manner as ordered by the engineer. The machine used shall be of type approved by the engineer for use in the work and shall be of such design as to turn over and thoroughly mix a previously measured quantity of ingredients. Either the tumbling box, Cockburn machine, Ransome machine or gravity machine will be preferred, but the continuous feed or screw type of concrete mixer will not be allowed. All the concrete will be measured dry into the machine in the proportions above specified, and water added during the mixing to thoroughly wet and temper the concrete, and so that the mixed mass shall be soft and plastic, but care must be taken not to add an excessive quantity of water so as to drown and injure the strength of the concrete. Concrete wherever used must be quickly laid in sections and layers not exceeding 9 ins. in thickness, and shall be thoroughly rammed, with rammers of whatever form the engineer shall approve, until water flushes the surface. Each layer of concrete after it has once set, must be cleaned and brushed and the entire surface slushed over with liquid cement before any additional concrete is laid thereon. No working upon, wheeling or walking on any fresnly laid concrete will be allowed until at least 12 hours after laying, and no wheeling or heavy work shall be carried on upon any bed of concrete without previously laying down wood planks. No concrete may be used in any part of the work which indicates initial set of cement to have occurred before being rammed in place. Wherever cement masonry is laid in molds or forms, the face planking shall be thoroughly brushed over with liquid soft soap before laying concrete. In all cases the thoroughly seasoned tongued and grooved planed true, or preferably by covering the surface molds with sheet metal.

concrete masonry face will be exposed to view ished work, the face boards of molds must be

Portland cement only is used for making concrete, and this material is required to conform to the following specification:

Portland cement for mortar, pointing, concrete other purpose shall not develop initial set in



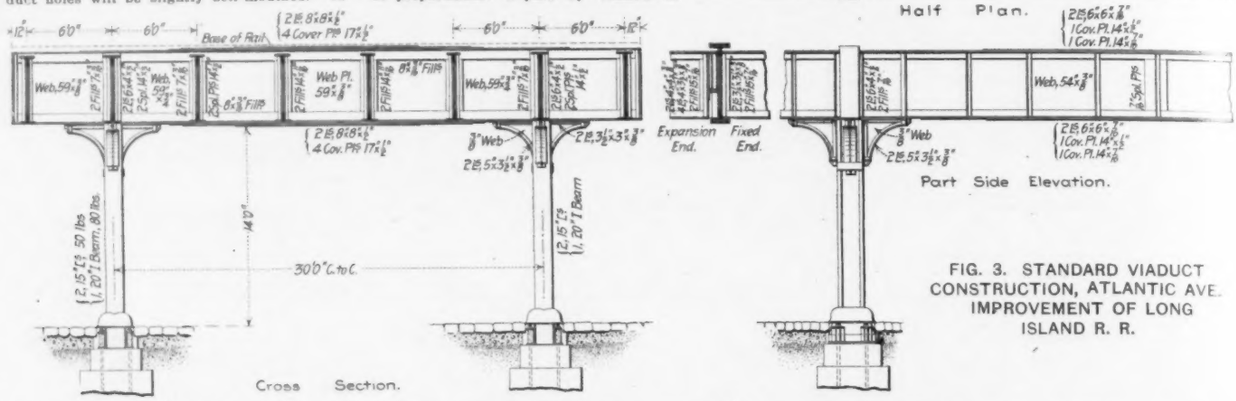


FIG. 3. STANDARD VIADUCT CONSTRUCTION, ATLANTIC AVE. IMPROVEMENT OF LONG ISLAND R. R.

Portland cement only is used for making concrete, and this material is required to conform to the following specification:

Portland cement for mortar, pointing, concrete or other purpose shall not develop initial set in less than 30 mins. tested in briquettes of neat cement, mixed with just sufficient water to well temper it, and at a temperature of 65° F., and in the air. Thin pats of cement, having feather edges and either placed in water bath, after having fully set, or remaining in air and dried out for any length of time, shall not show any sign of "checking" or disintegration. Fineness of grinding is considered very essential and shall be tested, and cement shall pass 99% through a No. 50 mesh sieve, 90% through a No. 100 sieve, and 74% through a No. 200 sieve. The ultimate tensile strength developed shall be:

	Age.	Lbs. pr sq.in
Neat cement.	In air until hard set; 24 hrs. in water	200
	In air 1 day; water 6 days	500
	In air 1 day; water 27 days	650
Mortar, 1 part cement. 3 parts sand	In air, 1 day; water, 6 days	150
	In air 1 day; water 27 days	250

The requirements for brick and stone and for the workmanship of brick and stone masonry were such as are common in first-class work. The requirements for the steel used were the same as those for the steel used in the viaduct construction, which are given further on. The specifications required that the steel construction used in the subway roof should be proportioned for the following loads:

1. The weight of the construction itself, together with the paving material, earth filling, concrete, etc., supported by it.

2. That one of the following live loads giving the greatest strains: (a) 150 lbs. per sq. ft. over the entire street surface supported; (b) 250 lbs. per sq. ft. covering an area on the street surface 10 ft. wide and extending across the subway transversely; or where center posts are used, 375 lbs. per sq. ft. for an area of the same width extending from one side to the center of the subway; (c) 15,000 lbs. on each of two wheels 5 ft. apart, placed to produce maximum strains in the parts considered.

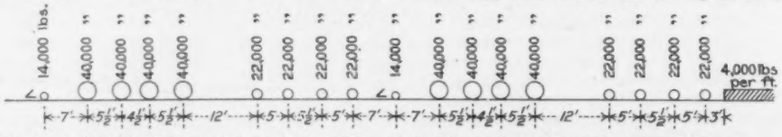


FIG. 4. DIAGRAM OF TRAIN LOADS USED IN CALCULATING VIADUCT STRUCTURE.

No addition will be made to these loads for impact and the unit strains of all kinds hereafter specified may be increased 25% when the dead load is combined with live loads (a) and (b), and 50% when combined with live load (c). Due consideration will also be given to the distributing effect of the concrete and earth filling in each particular case. Variation in temperature to the extent of 150 degrees Fahrenheit shall be provided for.

VIADUCT CONSTRUCTION.—As previously noted, there will be two stretches of viaduct construction. The first of these will be four-track viaduct, and the second will be two-track viaduct. The structure will be the same for two-track and four-track work, except, of course, in dimensions, and is shown in its general details by Fig. 3. It is a typical plate girder elevated railway construction, with the columns carried on concrete pedestals. The electric wire conduits are to be constructed under the street surface generally close to the line of column footings on each side, and are to conform in materials and workmanship to the specifications quoted above. The structural details of the viaduct work are given by the drawings, the materials used are required to conform to the following specifications:

With the exception of anchor bolts, anchor plates and wheel guards, all parts of the metal structure shall be of open-hearth soft steel. Steel made in an acid furnace shall contain not over 0.08% of phosphorus and not over 0.06% of sulphur. Steel made in a basic furnace shall contain not over 0.04% of phosphorus and not over 0.05% of sulphur. Steel for rivets shall have an ultimate strength of 48,000 to 56,000 lbs. per sq. in.; an elastic limit not less than 28,000 lbs. per sq. in.; a minimum elongation in 8 ins. of 28%, with a reduction of area of 56%, and must be capable of being bent flat on itself when cold, without sign of fracture. Steel for all plates and shapes shall have an ultimate strength of from 52,000 to 62,000 lbs. per sq. in.; an elastic limit of not less than 28,000 lbs. per sq. in.; and a minimum elongation in 8 ins. of 25%, with a reduction of area of 50%. It must be capable of being bent double when cold, with no sign of fracture.

The viaducts shall be proportioned for the following loads: (1) The weight of the entire structure, estimating the weight of timber deck, rails, fastenings, etc., at 450 lbs. per lin. ft. of each track, unless otherwise noted on drawings accompanying the letter of invitation. (2) A live load on each track, consisting of two engines coupled and followed by a uniform train load of 4,000 lbs. per lin. ft.; as per diagram, Fig. 4. Or (where it produces greater strains) 100,000 lbs. equally distributed on two pairs of driving wheels 7 ft. 6 ins. c. to c.

The length of span to be assumed for calculation shall be as follows: (1) All beams or girders resting on masonry, the distance c. to c. of bearing plates; (2) Longitudinal girders framed into or supported by transverse girders, the distance c. to c. of transverse girders; (3) Transverse girders, supported by columns, the distance c. to c. of columns. The depth to be assumed for the calculation of plate girders shall be the distance between centers of gravity of flanges, unless this exceeds the distance from back to back of flange angles, in which case the latter distance is to be taken. All parts of the structures shall be so proportioned that the sum of the maximum live and dead loads, together with the impact, shall not cause the tensile strain to exceed 15,000 lbs. per sq. in.

For compression members, the permissible strain of 15,000 lbs. per sq. in. shall be reduced in proportion to the ratio of the length to the least radius of gyration of the section by the following formula:

$$P = 15{,}000 \div \left\{ 1 + \frac{l^2}{13{,}500\, r^2} \right\}.$$

P = permissible working strain per square inch in compression;
l = length of member in inches between centers of connections;
r = least radius of gyration of the section in inches.

No compression member, however, shall have a length exceeding 100 times its least radius of gyration, except lateral struts, which may have a length not exceeding 120 times the least radius of gyration. Rolled beams will be proportioned by their moments of inertia. In the case of columns subject to combined bending and direct strains, if the maximum strain which can be calculated by assuming a maximum of two tracks fully loaded and combining the direct strains from dead load, live load, and impact either with those from wind or centrifugal force jointly or with that from momentum or train, exceeds the above limiting strains in clause No. 271 by more than 30%, the sections must be increased to reduce the strain within that limit. The shearing strain on rivets and bolts, per square inch of section, shall not exceed 11,000 lbs. and the pressure upon the bearing surface of the projected semi-intrados (diameter × thickness) of the rivet or bolt, shall not exceed 22,000 lbs. per sq. in., impact being included in all cases. In case of field riveting, the number of rivets thus found shall be increased 25%. Net sections must be used in all cases in calculating tension members.

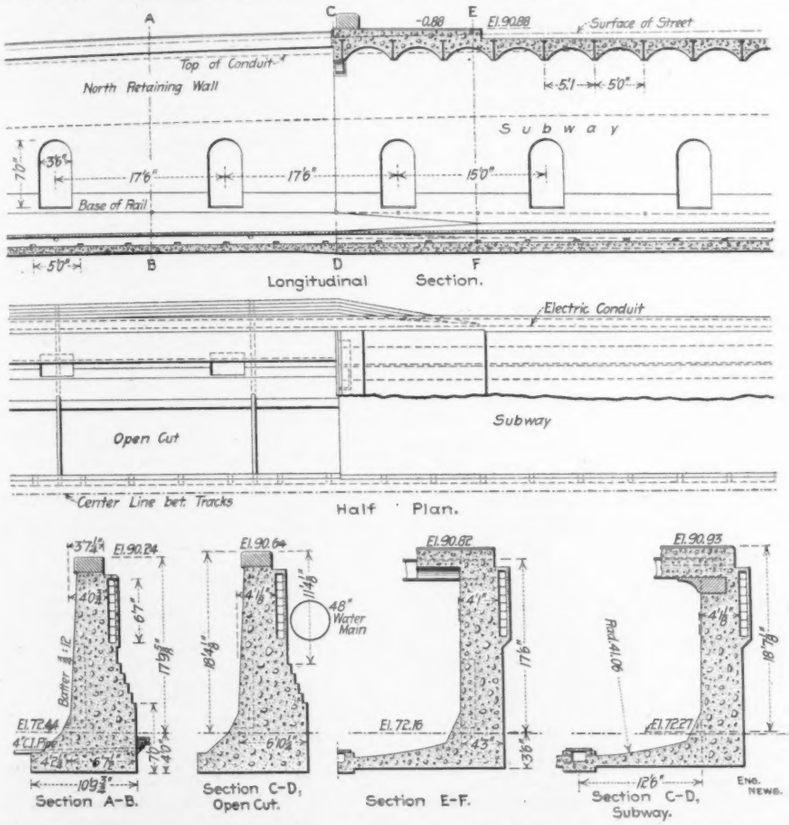


FIG. 5. TYPICAL OPEN CUT CONSTRUCTION, ATLANTIC AVE. IMPROVEMENT OF LONG ISLAND R. R.

Where
I = effect of impact;
S = maximum live load strain; and
L = loaded length, of single track, in feet producing maximum live load strain.

Wind pressure shall be assumed acting in either direction horizontally: (1) At 30 lbs. per sq. ft. on the exposed surface of the entire structure, as seen in elevation, in addition to a train of 10 ft. average height, beginning 2 ft. 6 ins. above the base of rail and moving over the bridge; (2) At 50 lbs. per sq. ft. on the exposed surface of the entire unloaded structure, as seen in elevation. In the determination of the requisite anchorage for the loaded structure, the train shall be assumed to weigh 800 lbs. per lin. ft. When the structure is on a curve the additional effect due to the centrifugal force of as many trains as there are tracks shall be calculated by the following formula and added to the live load strains:

C = .02 W D for curvature up to 5°

Where
C = centrifugal force in lbs.;
W = weight of train in lbs.; and
D = degree of curvature.

For curves sharper than 5°, reduce the coefficient .02 by 0.001 for each degree over five. The eccentricity of the track must also be considered, and girders proportioned accordingly. For longitudinal strains in columns and the attachment of fixed spans the momentum produced by suddenly stopping the train shall be considered, the coefficient of sliding friction being assumed as 0.2. Where the structures are built for three or more tracks, however, centrifugal force and momentum of train shall be calculated for two tracks only as the maximum.

OPEN CUT CONSTRUCTION.

The termini of the subway sections approach the street surface by means of open cuts, and typical details of one of these are given by Fig. 5. As will be observed, the walls of the open cut are practically continuations of the side walls of the subway. The invert of the subway is also continued for 100 ft. into the open cut.

ENGINEERS AND CONTRACTORS.

The work described is being carried out by the Long Island R. R. Co., under the direction and according to the designs of Mr. J. Vipond Davies, M. Am. Soc. C. E., as Chief Engineer, Mr. Geo. Sergeant, Jr., is Principal Assistant Engineer, and Mr. J. B. French is Bridge Engineer. The contractors are: The Wilson & Baillie Mfg. Co.; John C. Sheehan & Co.; John McNamie; The United Engineering and Contracting Co., and The American Bridge Co.

THE ENGINEER OF THE TWENTIETH CENTURY.*

By Robert Moore,† M. Am. Soc. C. E.

At our last annual convention my predecessor addressed you upon Engineering in the Nineteenth Century, and at this meeting our secretary has given you a sketch of the history of our own society during its first fifty years, which will have closed before our next annual reunion. It has seemed to me, therefore, not inappropriate that to-day I should take a glance towards the future, and say something concerning the outlook for engineering and for our own society in the new century upon which we have just entered.

What kind of a man, then, will the engineer of the new century be, and what the scope of his work, as compared with the engineer and his work in the century which has just closed? Before proceeding to consider this question let me say that in speaking of the engineer I shall use the word in the comprehensive sense of Thos. Tredgold's well-known phrase, as one who directs "the great sources of power in nature for the use and convenience of man," a sense which includes every subdivision of this work.

Until very recent years the engineer, as a man of learning, even in his own profession, has not been the peer of the clergyman, the teacher, the lawyer or the physician. In fact, speaking broadly, engineering has not been one of the learned professions. And for this the reasons are not far to seek. As a distinct profession, that of the engineer is much younger than those just mentioned, and, what is even more to the point, the sciences which set forth the laws that govern the materials and forces of nature and underlie engineering works, are all of recent development.

Historically, as we all know, the oldest profession is that of the priesthood. How to ward off evil spirits and propitiate the invisible powers has been one of the earliest studies of every people, and they who know, or were believed to know, best how these ends might be accomplished, were differentiated into a separate class, who became the custodians of all the learning then attained by men. The priests were the scholars, the learned men of their time. As such, they were the medicine-men, or physicians, the healing art being at first almost wholly a matter of incantation. As conservators of tradition they became the arbiters in disputed matters, and thus the lawyers and judges. As the only learned men they were, of course, the first teachers or instructors in letters. In important structural works, the first of which were largely

*Presidential address at the annual convention of the American Society of Civil Engineers, at Washington, D. C., May 20, 1902.

†Consulting Engineer, Laclede Building, St. Louis, Mo.

temples, they were the natural leaders, and as such the first architects. Their early activity in the field of engineering may be seen in the fact that amongst the Romans, the most practical of nations, the high priests were styled pontiffs or bridge-makers, and the high priest was pontifex maximus, or the chief bridge builder. The oldest engineering society was, no doubt, that of the Fratres Pontifici, or the bridge-building brotherhood of Benedictine monks, who, during the middle ages, chose as their special work the building and repair of bridges. How well much of this early work was done, many an old cathedral and many an ancient bridge bear abundant witness.

In process of time, however, each of these subordinate fields of knowledge and practice became so extensive and so exacting of time, as to be beyond the compass of any one man, or class of men, and each gradually became the special field of a distinct profession. In the order of time the physician, the lawyer and the teacher—the professor par-excellence—came first. Then followed the architect as the skilled designer of houses, and last of all, the engineer or the millwright and the skilled maker of roads and bridges.

But the structures which the first engineers were called to build, while they demanded skill and courage and judgment, called for little of the learning found in books. Some practical skill in arithmetic and geometry, and, possibly trigonometry was the limit of the scientific knowledge required. Engineering was an art, and not a science, and the engineer was little more than a highly skilled workman. As in all the arts, the standard method of instruction was that of apprenticeship, in which by word and by example the master slowly transmitted to his pupil the art and mystery of his craft. James Brindley, builder of the first important English canal, was a cotter's son and served seven years as a wheelwright's apprentice. George Stephenson, builder of the first successful locomotive and railway, was eighteen years of age before he learned to read. Thomas Telford, builder of roads and bridges, and first President of the Institution of Civil Engineers, was the orphaned son of a shepherd, and served a seven years' apprenticeship as a stonemason. Smeaton and Watt were mathematical instrument makers, and both men of considerable training, but as engineers they were almost wholly self-taught.

In like manner, in our country, the engineers who, in the first half of the nineteenth century built our first canals and railroads—such men as James Geddes, Benjamin Wright, Canvass White, Loammi Baldwin, Nathan Roberts and Jonathan Knight—were all men with no learning beyond that of the elementary schools, and their professional training was gained in the school of experience. Though men of judgment, skill and courage, men of force and of brains, they were not men of science.

For beyond mathematics, the higher developments of which were known only to a very few, the sciences which underlie the engineer's work had not yet taken form. Structural mechanics, thermodynamics, chemistry and electricity as organized sciences did not yet exist. But since Carnot, Davy, Faraday, Joule, Rankine, Maxwell, Clausius and others like them have done their work, all this is changed, and he who would now enter the field as an engineer, with the slightest hope of success, must have mastered the sciences which the labors of these men have developed. The knowledge which had to suffice for his predecessors is no longer enough. Out of this new need, and as the shortest road to such mastery, has grown the engineering school, in which these new sciences are specially taught—a growth which has been characteristic of the last half century, and which, during the last few years, has been phenomenal.

As introductory to the engineering school, and as the foundation upon which its work must be laid, there is, of course, needed a thorough grounding in the general principles of the sciences of matter and motion, to wit: elementary mechanics, physics, and, above all, mathematics, or the science of number and measurement. But, in addition to this training in the elements of the mathematical and physical sciences, there is also needed, for the proper equipment of the engineer a broad, elementary training in the other departments of human knowledge, which are by contrast metaphysical and as yet unmathematical.

For we canot know anything correctly except as we know its limits and its place in the general system of things. Even the place where we stand on the earth cannot be accurately located except by its co-ordinates of latitude and longitude, which define its position with reference to the whole globe. Every well trained professional man, therefore, must have, as part of his equipment, the broad outlines of general knowledge. He must know something of language and literature, of political science and of history, something of what the world's workers have done and of what its thinkers have thought, in order that he may correctly understand and evaluate the knowledge peculiar to his own calling. To know everything about something, which is his business as a professional man, he must also know something about everything.

A broad basis of general knowledge such as shall put the man in touch with all times and with all men must, therefore, precede the special knowledge of the technical school. Otherwise there may be much mastery of detail, a microscopic thoroughness, but not the firm grasp and clear insight which the broader training gives. In fact, if a choice must be made, it is better to shorten, or even to omit, the training of the technical school, leaving the man to supply this deficiency for himself, rather than to sacrifice the broader outlook and the wider sympathy which is given by the more diversified training in the outlines of general knowledge.

It is safe to say, therefore, that in the new century he who aims at the highest success as an engineer must be a more learned man than his predecessor of the last century. He must be master of the strictly engineering sciences and as a basis and introduction to these he must have the wider training of the preparatory school and the college.

All this, however, is but the beginning. For in addition to the training which is to be gained in schools and from books, he must have the training which is to be gained only in the post-graduate school of actual life and work, in which alone the final degree of engineer in fact can ever be attained.

For it must never be forgotten that for real success in any calling, be it that of the professional man or the man in political or commercial life, there is needed something which neither books nor schools alone can teach, something which is partly the result of inherited qualities and partly the result of our daily contact with men and things, something which is the resultant of the reaction of our inheritance upon our environment, and which we sum up in the word character. Before there can be real power in any walk in life there must, in addition to technical training, be energy, veracify, self-respect, courage and address. That is to say, before we can have the able engineer, or the worthy examplar of any profession we must, first of all, and more than all, have a strong and worthy man.

And for the development of these manly qualities, what better school can there be than is found in the daily life of the working engineer. For, first of all, in so far as he is an engineer must he be an open-minded and essentially truth-loving man. As the prime condition of his control over the force of nature he must see things and their relative values, not as he wishes them nor as he already things them to be, but exactly as they are in fact. With the facts before him he must have the skill to rightly interpret them, and to this he must add the courage to make his actions conform to his convictions. He must be a man of invention and resource, one who can act promptly as well as see clearly.

At his own peril he must not deceive himself. Otherwise his works will fail and he fail with them. And with equal emphasis is he warned against all attempts to deceive others, for in no calling are such attempts so quickly detected or so certainly futile. A false theory in medicine, in law, or in theology, may live, as many have lived, undetected for a thousand years, but a false theory in engineering is disproved by the first attempt to put it in practice. If its embodiment be an engine it refuses to go, if it be a structure it falls to pieces. The pretender, the quack, the charlatan have no abiding place amongst engineers. They are so quickly unmasked that they speedily disappear. No one, in fact, is so sure to be known at his true value as is the engineer, and no one can so well afford to discard all artificial aids to recognition. What he does is in the sight of all men, and speaks for him.

> "Work of his hand
> He nor commends nor grieves
> Pleads for itself the fact
> As unrepenting Nature leaves
> Her every act."

And if it be a question of motive, to whom is the duty and dignity of a life of service brought more closely home than to him whose life-work is found in directing the sources of power in nature for the use and convenience of man? And what greater pleasure and satisfaction can there be than a life devoted to solving the riddles which nature everywhere propounds, knowing as we do that every new solution means a fresh source of power and benefit to mankind? In fact, the whole tendency of the engineer's life and work is to clarify and quicken his intellect, to train his will, and to strengthen every good impulse. How many shining examples and proofs of this are found in the roll of members, living as well as dead, of our own society, how many have we ourselves known—strong, alert, kindly, clear-headed men, men quick to respond to every call of duty and who could be trusted to the uttermost in every relation of life.

If to a character such as this we add a grasp of the broad outlines of general knowledge and a command of the new sciences which the labors of the last two generations have bequeathed to us, we have the man who will be the typical engineer of the new century. He will be not unlike the engineer of the last century; will, in fact, be his true successor, and considering his greater opportunities no more to be commended. Yet as a man of wider knowledge and ampler intellectual resources he cannot help being a man of greater power. Great as have been the men and great as has been the work of the engineers of the last hundred and fifty years, during which the steam engine, the railroad, the telegraph, the telephone, the power press and the myriad other improve[illegible] have revolutionized the conditions of human life, m[illegible] it not only longer but richer and better worth the liv[illegible]re is reason to believe that even greater work is in s[illegible]r our successors. Certain it is that as knowledge [illegible] the field for its application to the uses of daily li[illegible] also grow. Even now, almost every process of m[illegible]ture and transportation, as well as all the machin[illegible] war, both on land and on sea, are the work of th[illegible]neer. And in the future, even more than in the pre[illegible] the secrets of power be in his keeping, and more[illegible] more will he be a leader and benefactor of men. Th[illegible] place in the esteem of his fellows and of the world [illegible]keep pace with his growing capacity and widening [illegible]ment is as certain as that effect will follow cause.

In this higher development of the engineer and [illegible] work this society, as the leading organization of its k[illegible] the country where engineers have accomplished m[illegible] certain to bear an important part. This it will do [illegible]rt by the intellectual stimulus of its papers and di[illegible]ions. Even now our transactions are an essential part [illegible] library of every working engineer and of every engineering school. But more important than the intellectual stimulus of our transaction will be the moral stimulus of personal contact and acquaintance made possible by our meetings. It is, in fact, hard to overestimate the value of such meetings in quickening the interest and raising the standards of those who take part in them. Nothing is so vitalizing as the meeting of those like sympathies and common pursuits. Scattered, the embers may die out, in contact they burst into flame.

But animated by the inspiration of example, personal contact and friendship, hardly any limit can be placed upon the effect of an organization such as ours in lifting our profession to the highest plane of real service and honors well deserved.

A $15,000,000 CHICAGO HARBOR IMPROVEMENT is being talked about; but as yet the project seems to have but a thin backbone. The harbor would be located just south of the mouth of the Calumet River, with a system of docks, elevators, warehouses, etc., at a point where the four belt-line railways touch the shore.

DEFECTS OF M. C. B. COUPLERS.*

By R. D. Smith.†

The Interstate Commerce Commission recently addressed a letter of inquiry concerning the operation of the safety appliance law to the general managers of different railways. One of the questions asked is: Whether the application of automatic couplers has resulted in greater safety and economy in the operation of trains and in terminal switching? The answer to this would undoubtedly be a practically unanimous affirmative.

From another paragraph of the letter it is evident that there is some opposition to the M. C. B. coupler on the ground that it has not entirely fulfilled the expectations at the time of its adoption. Extensive use generally discloses certain defects of design or construction in any new mechanical device, and when one considers that the automatic coupler was a radical departure from the appliances used at the time of its introduction, he must at least concede that it has given excellent results. There are probably very few who are familiar with the present coupler, and its predecessor, the link-and-pin drawbar, who will seriously contend that the automatic coupler is not a great and decided improvement, although it has not proved satisfactory in every respect.

It must be remembered when considering the defective and weak points of the M. C. B. coupler, which have been developed in service, that the coupler now in use does not differ in essential dimensions and strength from the original coupler designed for cars of about half the capacity of those now being built. Furthermore, longer trains are being handled by the heavy engines, and the cars receive very severe service in switching and terminal yards. The fact that the element of personal danger has been largely eliminated by the automatic coupler is believed by the writer to be responsible to a great extent for the damage caused by rough switching.

In order, however, to get facts showing the actual results obtained in service it will be necessary to present a few statistics concerning couplers and their performance. The C., B. & Q. Ry. compiles a monthly "break-in-two" statement, giving the number of trains parted and the defect of the coupler which caused the parting. A summary of these statements for the past three years is given in Table I., as the figures will tend to show the comparative strength of the different parts of the coupler mechanism:

This table refers only to coupler failures on the road, and does not include failures or breakages in switching or terminal yards. The first part of the table gives the number of failures during the year due to the different causes, and what per cent. this number is of the total number of failures for the same period. During the first

*Abstract of a paper presented at the May meeting of the Western Railway Club, at Chicago. The same subject was editorially descussed in our issue of Jan. 30, 1902.

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TABLE I.—Record of M. C. B. Coupler Defects; Chicago, Burlington & Quincy Ry.

Defects.	Year ending Nov. 30, 1899. No. failures.	Per cent.	Year ending Nov. 30, 1900. No. failures.	Per cent.	Year ending Nov. 30, 1901. No. failures.	Per cent.	June 1 to Nov. 30, 1900. No. failures.	Car miles per failure.	Dec. 1, 1900, to May 31, 1901. No. failures.	Car miles per failure.	June 1 to Nov. 30, 1901. No. failures.	Car miles per failure.
Lock pin defective	8	1.62	24	4.25	14	2.06	11	10,043,044	6	17,645,366	8	14,530,344
" worked open	132	26.84	101	17.91	45	6.61	37	2,985,770	24	4,411,341	21	5,535,369
" pin worn	16	3.25	13	2.31	3	.44	..	.....	1	105,872,206	2	58,121,377
" block defective	10	2.03	19	3.37	11	1.62	12	9,206,124	5	21,174,441	6	19,373,792
" " worn	5	1.01	2	.36	15	2.20	2	55,236,743	9	11,763,578	6	19,373,792
" " bolt bent	5	1.01	..	....	8	1.17	..	.....	4	26,468,051	4	29,060,688
" would not drop	6	1.22	..	....	1	.15	..	.....	1	105,872,206	..	.....
Knuckle defective	113	23.00	151	26.77	210	30.85	83	1,331,006	86	1,231,072	124	937,441
Knuckle worn	36	7.31	56	9.95	69	10.14	30	3,682,449	30	3,529,073	39	2,980,583
Wrong knuckle	4	.81	1	.18	6	.88	..	.....	5	21,174,441	1	116,242,754
Pivot pin defective	23	4.68	21	3.71	33	4.83	13	8,497,960	15	7,058,147	18	6,457,931
Drawbar lugs broken	40	8.12	40	7.09	78	11.45	22	5,021,522	31	3,415,232	47	2,473,250
No visible defects	42	8.54	62	11.00	84	12.33	31	3,563,660	44	2,406,186	40	2,906,070
Coupler body broken	24	4.88	40	7.09	63	9.25	26	4,248,980	25	4,234,890	38	3,059,023
Not specified	21	4.26	28	4.95	26	3.82	15	7,364,900	13	8,144,016	13	8,941,750
Foreign substance under lock	3	.61	..	....	1	.15	..	.....	..	.....	1	116,242,754
Too much play	4	.81	6	1.06	12	1.76	5	22,094,697	7	15,124,601	5	23,248,551
Miscellaneous	..	....	..	....	2	.29	..	.....	1	105,872,206	1	116,242,754
Total	492	100.00	564	100.00	681	100.00	287	384,925	307	344,860	374	310,803
Total freight-car miles								110,473,486		105,872,206		116,242,754

half of the three years covered by these figures there were some link-and-pin couplers in service, and as it is impossible to separate the link-and-pin car mileage from the mileage of cars having automatic couplers, no attempt has been made to determine the number of car miles per failure for that period. The figures given, however, are for automatic coupler failures only; the link-and-pin failures were not considered.

The second part of the table is based on results obtained after the link-and-pin coupler was abolished. In this section the number of "break-in-twos" due to different causes during periods of six months and the number of car miles per failure are shown. These figures should be of value in considering the subject of couplers, as they show that certain forms of failures have increased very rapidly during the past year.

Particular attention is called to a few of the more important defects that are being observed in service. There appears to have been a decided decrease in the number of "break-in-twos" due to the lock working open. There were 37 "break-in-twos" attributed to this cause during the six months ending Nov. 30, 1900, with an average of 2,985,770 car miles per failure; during the next six months there were 24 "break-in-twos," with an average of 4,411,341 car miles per failure; while for the last six months there were 21 trains parted, with an average of 5,535,369 car miles per failure. One or two of the minor defects also show some improvement, but the lock working open is about the only important defect which is decreasing in frequency, while on the other hand there have been large increases from other causes, with a corresponding decrease in car mileage per "break-in-two."

A good illustration of a defect which has increased very rapidly is to be found under the heading of "Drawbar Lugs Broken." This defect shows a decided increase during the second six months, while during the third six months the car mileage per "break-in-two" from this cause has decreased to less than half of what it was during the first six months. The number of "break-in-twos" due to knuckle failures and to defective pivot pins has also increased, but not as rapidly as that due to lug breakages.

As Table I. does not account for yard failures, several scrap piles containing a total of 345 couplers were examined with the idea of determining the most common cause of removal, and the results are given in Table II.:

TABLE II.—Record of Scrap Coupler Examination.

	Number.	Per cent.
Both lugs broken off	35	10.14
Bottom lug broken off	13	3.77
Top lug broken off	114	33.04
Broken guard arm	57	16.52
Broken through face	67	19.42
Broken through shank	34	9.85
Bent guard arm	18	5.23
Head broken off just back of bracket	3	.87
Head broken off from part	3	.87
Broken through key slot	1	.29
Total	345	100.00

These figures show that nearly half of the scrap couplers were condemned on account of broken lugs, and thereby confirm the other statistics, which indicate a very large increase in the number of lug failures. Further consideration reveals the fact that the breakage of top lugs constitutes over 70% of the total lug failures. The question which now presents itself is: "What causes the top lug to break more frequently than the bottom lug?"

The breaking of the pivot pin is one of the common forms of coupler failure, and it is believed that this is the cause of the majority of breakages of top lugs. It is found that the pin breaks at about the middle and the lower half drops out, putting all the strain on the top lug. In some instances the pin may have been bent, but not broken, although in such a case the bottom lug or both lugs would be as liable to break as the top lug.

This breakage of pivot pins has become so common, and the lower halves of the pins may be found to such an extent in any large freight yard, that it recalls the conditions existing when the old link-and-pin coupler was in service. It is not intended to convey the impression that the number of broken pins is as great now as it was with the link-and-pin coupler, but the number is increasing and is attracting attention. Any person who is skeptical concerning this matter can probably obtain a little information by examining a few of the small scrap piles which are usually found at various places in large switching yards.

It is believed that the statistics based upon the coupler failures upon the road do not show the true relation between pivot-pin failures and lug failures, as it is very probable that the broken pins are frequently lost, or if the pins are only bent they are not reported. The mechanical engineer of one road running into Chicago states that he believes that fully 90% of the lug breakages are preceded by bending or breakage of the pins. The representative of a large coupler concern also states that in his opinion the bending of the pins is responsible for some of the lug breakages.

It is evident that the number of lug breakages is excessively large and that it is necessary to do something to obviate this condition. There does not appear to be any good reason why the pins and lugs cannot be strengthened enough to bring this form of failure down to a normal amount. Some of the coupler manufacturers have been trying to relieve the pin and lugs of part of the strain by putting a hook on the end of the knuckle projecting through a hole in the side of the coupler head, and some attempts have been made recently to increase the diameter of the pivot pin.

The M. C. B. specifications for couplers give the dimensions of pivot pins and require the material to be of steel, carefully annealed after forming. It is further specified that the holes in the lugs and knuckles be drilled or drifted to a diameter 1-32-in. greater than that of the pivot pin, but an examination of several new couplers, of different manufacture, shows that this requirement has not been rigidly followed. In one new coupler the holes in the lugs and knuckle are 3-32-in. larger than the pivot pin; in another new coupler the holes in the lugs are 1-32-in. larger than the pivot pin, while the hole in the knuckle is 5-64-in. larger. Several knuckles were also examined, and some of the holes were found to be elliptical and to contain sand, which proves that they had not been drilled or drifted out.

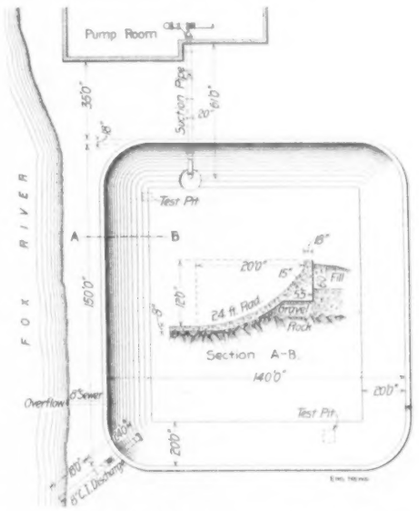
This matter is one of considerable importance which should receive more attention from manufacturers, and inspectors should not accept couplers or knuckles which do not conform closely to the specifications. There is some tendency for the holes to wear elliptical, and if the pivot pin fits closely in the hole this tendency is somewhat diminished. There is also more opportunity for the pin to bend if it has very much clearance in the holes. It might be productive of some improvement if the M. C. B. specifications recommended a certain composition for steel used in pivot pins. The chemical composition of the pins is not specified, and an analysis recently made of three different pivot pins revealed a great difference in composition.

CONCRETE LINED RESERVOIR WITH CONCAVE SLOPES AT AURORA, ILL.

The water supply of Aurora, Ill., is obtained from wells, which are connected directly to the suction main of the pumping station. The quantity thus obtained, however, is not sufficient for present needs, and the Board of Public Works has decided to increase the supply to 2,000,000 gallons per day by putting in the air-lift system and forcing the water to a new storage reservoir of 2,000,000 gallons capacity, from which the pumping engines will draw the supply for distribution. This reservoir will be 140 × 150 ft. on top, with corners of 20 ft. radius, built mainly in limestone excavation, and will have a concrete lining. The side slopes of the reservoir are to be made concave, with a radius of 24 ft. The plans and specifications for the work have been prepared by Mr. H. D. Hallett, M. West. Soc. C. E., Consulting Engineer, of Aurora, Ill. Mr. W. R. Rees is Superintendent of Water-Works.

Mr. Hallett states that he has never before used the curved form of side, and has never even seen it used. His reason for adopting it was to allow for the expansion of ice in the event of the water freezing, and he thinks the plan was the best that could be made when all the conditions of the location are taken into consideration.

In earth the excavation will conform to the curve of the sides. In rock the excavation will be made to conform as nearly as possible to this curve, but from its stratified character it will take approximately the form shown in the cross-sections. All spaces below the outer line of the curved concrete lining will be filled with crushed



Concrete-Lined Reservoir for Aurora, Ill.
H. D. Hallett, Consulting Engineer, Aurora, Ill.

stone or spalls, and all the spaces between the stones washed full of sand and thoroughly tamped to fit the curved line of the concrete. The lining will be of No. 1 concrete, with a thickness of 8 ins. on the bottom and 12 to 15 ins. on the sides, increasing to 18 ins. for the coping wall. Where the rock does not extend to the level of the top of the reservoir the sides will have a concrete backing of No. 2 concrete, as shown. An abstract of the main part of the specifications is given below:

The No. 1 concrete shall be made of the following proportions: 1 part native Portland cement, 2 parts clean, sharp sand, free from clay loam or vegetable matter, and 3 parts crushed stone thoroughly cleansed from dust or dirt. If mixed by hand, the sand and cement shall be mixed together dry; the crushed stone thoroughly wet and then mixed with the sand and cement by turning until all the voids in the crushed stone are filled, water enough being added so it will tamp properly. If the voids in the stone are not all filled after the concrete has been tamped in place, then more cement and sand shall be added. The concrete must be one solid homogeneous mass after it is tamped in place, with no open spaces in the crushed stone. No. 2 concrete will be made of the following proportions: 1 part native Portland cement, 3 parts clean sand and 6 parts crushed stone, mixed as specified for No. 1 concrete.

Concrete shall be placed in position before beginning to set. The whole operation of mixing, spreading and compacting shall be performed as expeditiously as possible, with a sufficient force of skilled men; and the whole surface shall be protected from the sun and wind until set. Any cement mortar or concrete which has wholly or partially set before being placed in the wall shall be removed and replaced at the expense of the contractor.

The concrete shall be spread in layers not more than 6 ins. in thickness and thoroughly rammed until free mortar appears on the surface. In putting new concrete on work that has set, the old surface of the work shall be wet and then a thin coat of cement mortar (1 part cement and 2 parts clean, sharp sand) shall be spread over the surface of the old work before the new concrete shall be added.

After the construction of the bottom and walls, and after all frame work has been removed, the walls and bottom shall be thoroughly cleaned and kept constantly damp by sprinkling. The whole inside surface of the walls and bottom shall be washed with a wash made of cement and water just thick enough so that it can be easily spread on with a broom or brush, and then covered with ½-in. of plaster, composed of 1 part cement and 1½ parts clean, sharp sand, troweled with a wooden trowel and then washed with medium thick coat of cement wash. The whole to be expeditiously put on so as to set, shrink and harden with the concrete walls.

The crushed stone must be broken to such sizes that no piece will be larger than 1 in. in its greatest dimensions or any stone smaller than ⅛-in. and free from all dirt and dust.

All cement shall be native Portland cement and shall be furnished in well-made barrels or bags, and shall be

stored in a warehouse that shall fully protect it from the weather. Said warehouse shall have a floor at least 6 ins. above the ground. All cement to be used in this work shall be delivered at the warehouse at least 10 days before it shall be used, so that sufficient time will be given for examination and testing. All cement used shall be subject to the following test: Neat cement mixed to a stiff plastic consistency and made into flat cake above ½-in. in thickness (when set hard), shall be immersed in water for three days or more, and shall show no cracking or distortion. The same kind of cakes may be subjected to a steam bath and afterwards immersed in water at 180° F., and shall show no signs of distortion or disintegration.

No more than 15%, by weight, shall remain on a sieve with 10,000 meshes per sq. in. Briquettes made of neat cement shall develop the following tensile strength per square inch: One hour in air, 23 hours in water, 150 lbs.; one day in air, 6 days in water, 400 lbs.

The reservoir shall have a sump pit constructed in the north side for the suction pipe; said sump shall be 8 ft. in diameter on top and 3 ft. deep below the bottom of the reservoir. Walls of same to be 15 ins. thick. The contractor will lay and calk the 20-in. suction pipe from the sump pit to the valve, as shown on the plan. The pipe will be furnished by the city.

There shall be constructed in the reservoir an outlet pipe 8 ins. diameter, 24 ft. of which will be cast-iron pipe and the balance will be sewer pipe. The outlet pipe shall be provided with a gate-valve placed as shown. There will also be constructed an overflow pipe of 8-in. sewer pipe. There shall be three openings left in the wall for discharge pipes from the wells.

In constructing the walls above the present surface of the ground, the filling or backing shall be tamped in layers the same as the concrete and at the same time; no frame work to be used on the outside of the wall, except the top 8 ins. A sheet-iron defender will be used about 18 ins. wide, and will be pulled up as each layer of dirt and concrete is tamped in place; the sheet-iron must be kept about 10 ins. above the concrete, so as to prevent any dirt from getting into the concrete.

The south and west sides and where needed on the other side shall be filled above the present surface. Black dirt enough to cover the filling 8 ins. in thickness shall be provided, and the surface of the dirt when finished shall be left 6 ins. below the top of the wall. The side next to the river shall be filled with stone excavated from the reservoir to a width of at least 12 ft.

RELATION OF SURFACE TO MEAN VELOCITIES OF STREAM FLOW.

In the reconnoissance of streams carried on over large areas and extended up into the headwaters it is necessary to measure quickly the flow of a great number of mountain brooks and creeks. These fluctuate in volume very rapidly, not only from day to day, but from hour to hour, following the changes of temperature. For this reason great accuracy is unnecessary, since the stream may change in volume 10% or more in the course of the afternoon. On the other hand, it is highly important to obtain some statement of the ordinary flow, whether the quantity is 10 or 100 cu. ft. per sec.

Mr. Lippincott is particularly interested in the matter, as he is arranging with the superintendents of forest reserves in California to make measurements of the stream flow in the high tributaries of the Sierra Nevada. There most of the streams to be measured discharge from 10 to 100 cu. ft. per sec. over pebbly or stony bottoms, having depths of from ½ to 2 ft. He has had Mr. Jeremiah Ahern make analyses of the velocity measurements as determined by current meters for various streams. Further remarks on this subject, as made by Mr. Lippincott, are as follows:

On the Sacramento River, at Jellys Ferry, observations for velocities have been taken at the top, middle and bottom of each section at intervals of 20 ft. The channel is of boulders, the depths ranging from 3 to 5 ft. in the low-water stages. The relation of the mean velocity to the top velocity on each section was determined, and then the mean ratio for the entire measurement. The measurements were arranged in six groups, according to gage heights. In the first group the mean velocity was 87% of the surface velocity; in the second, 88%; in the third, 88%; in the fourth, 89%; in the fifth, 87%; in the sixth, 87%. The last group represents the highest water. The mean of 30 measurements gives a ratio of 88%.

A determination on the Tuolumne River, at Lagrange, also gives a coefficient of 88%. This river has a pebbly or stony bed, and the depths range from 1.12 to 1.84 ft. The velocities range from 3 to 5 ft.

On the smaller rivers the determinations were less satisfactory, because when depths become as low as 1 ft., top, middle and bottom velocities were seldom observed with meters, and unless we had three observations for velocity the mean velocity was not considered sufficiently accurate to justify a comparison with the surface velocity. The relative irregularities of the beds of the smaller streams also introduced wider ranges in the relation of surface to mean velocities.

On the San Gabriel River the following results were obtained at different points on the stream: 83, 94, 95, 89, 90 and 98%, giving a mean of 92%.

On the Santa Ana River the following determinations were made at Warm Springs: 96, 95, 91, 86, 90, 91, 96, and 93%, also giving a mean of 92%.

The channels of these two streams are relatively rough; the water surface is usually from 10 to 20 ft. in width, and the depths vary from 0.25 to 1 ft., for the stage of water observed. It is rather singular to note that the determination of these coefficients in the smaller and relatively rough channels shows a higher value than in the larger channels. As previously remarked, however, the determination for the San Gabriel and the Santa Ana are not considered entirely satisfactory, nor as reliable as the determination for the Sacramento. It is possible that the coefficients which we have determined for the smaller streams are too high, owing to the fact that the current meter could not be placed in the slowest film of water immediately adjacent to the bottom and sides of the channel, so that the mean velocity as shown may be slightly above the true mean velocity. This error would be relatively greater in small than in large streams, however. In the measurements of the small streams a Price acoustic meter has been used, which permits the center of the meter to be placed within at least 3 ins. of the bed of the creek.

In consideration of the above data it is believed that for ordinary streams discharging 100 cu. ft. per sec. of water, or less, on stony beds, that 0.9 of the maximum surface velocity for the section will represent the mean velocity for that section, said surface velocities being observed at numerous points across the stream.

FALL OF A TRAVELING ELEVATOR LEG AT BUFFALO.

A traveling elevator leg, 125 ft. high, on the Dakota Elevator, Buffalo, N. Y., was blown from its fastenings in a heavy windstorm on the night of May 6, and toppled over into the water. The accompanying cuts are reproduced from photographs taken after the accident, and we borrow the following account from the "Buffalo Express" of May 7:

The wind that did the damage came in the form of a squall, about the fiercest that ever visited this section. It came at 10.50 o'clock and lasted only three or four minutes. Tugmen about the harbor, who were on the dock at the time of the blow, say the velocity at the height of the squall must have come close to 100 miles an hour.

The Dakota Elevator, a new steel-structure building, was finished only a short time ago, its predecessor having been burned two years back. It has been in operation a month.

The elevator proper sets back from the edge of the Blackwell Canal about 50 ft. and from the edge of Peck Slip about 40 ft. On the 50-ft. width of dock on the Blackwell side, two portable towers or movable legs were operated. The towers were moved up and down the length of the dock on double sets of railroad tracks in front of the elevator. They elevate the grain from vessels lying by the dock, transferring it immediately to the big elevator behind them. By this system the elevator practically goes to the boats, and the vessels do not have to shift their positions when the grain beneath one hatchway has been cleaned up. Each tower is about 50 ft. long, 40 ft. wide and about 125 ft. high. They are of steel construction, with corrugated-iron covering. Inside are the expensive steam-shovel machinery and the motor for running the elevating apparatus.

Each tower is placed upon eight sets of trucks, four on each side. Thus two sets of parallel tracks are required about 30 ft. apart. The two towers are operated on the same tracks. Last night before the squall one tower was at the southern extremity of the tracks and the other was about 200 ft. to the north. It was the latter one that met with disaster. Each was lashed to a stout pile by a strong wire cable over an inch in diameter.

The squall struck both towers square from the south and at the height of the wind the cable holding the northerly tower snapped and the tall structure, with the wind pushing it, came down the track on its well-oiled wheels. At the end of each set of tracks was a heavy pile. These tripped the towering structure, and it fell headlong into Peck Slip, its base resting on the dock. The impact of the tower shook the nearby wharves and buildings, the shock being plainly felt along the mainland wharf of Buffalo Creek in the vicinity of Main, Washington and Illinois streets.

About 40 ft. of the lower portion of the tower rests on its side on the dock, the remainder slanting downward into the water. Nearly half the tower is submerged stretching at least half way across the slip.

FIG. 1. VIEW AT NORTH END, SHOWING WRECKED TRAVELING TOWER.

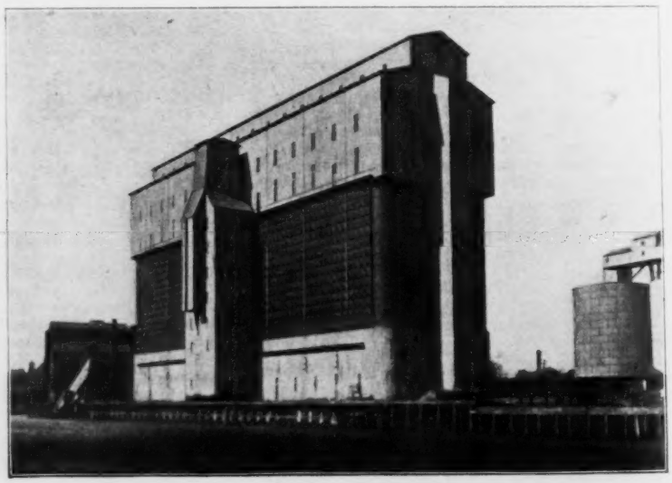


FIG. 2. GENERAL VIEW OF ELEVATOR, SHOWING SOUTH TOWER STANDING.

THE DAKOTA ELEVATOR, BUFFALO, N. Y.

For such work it is not always necessary, nor even desirable, to provide current meters, but the velocities can be determined by surface floats. In order to compute the total discharge it is necessary, however, to make certain assumptions as to the relation of the surface velocity as obtained by floats to the average of the whole stream. This matter has been the subject of investigation by Mr. J. B. Lippincott, M. Am. Soc. C. E., of Los Angeles, Cal., and other members of the Division of Hydrography of the U. S. Geological Survey.